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## Delta Regional Monitoring Program

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### *Monitoring Design Summary*



Technical Advisory Committee



Prepared for

Delta RMP Steering Committee  
November 3, 2014



## 1 Overview

This document summarizes the Delta Regional Monitoring Program's (Delta RMP) Year 1 draft monitoring designs for review and confirmation by the Steering Committee. Four distinct summaries are provided, one for each of the initial priority constituents: Pathogens, Current Use Pesticides, Mercury, and Nutrients. Each summary includes:

- Management and assessment questions addressed
- Recommended Year 1 monitoring (design, frequency, type, coordination, etc.)
- Budget estimates (with ranges to adjust for available funding)
- Monitoring sites (named and mapped)
- Data products
- Next steps in the design development process
- Appended background information

The recommendations presented here reflect input from subgroups of the Delta RMP Technical Advisory Committee (TAC). The purpose of this summary is to provide a decision basis for the Steering Committee and TAC to prioritize Year 1 activities, coordinate with other monitoring programs, and help establish institutional and funding agreements.

## 2 Assessment Questions

The Delta RMP monitoring designs are driven by management questions that reflect specific concerns about multiple aspects of the Delta and the impacts of human activities. Assessment questions address the management questions and lead to specific monitoring designs. The RMP Management Questions and the current Assessment Questions, highlighting Year 1 priorities, are provided in **Table 1**. This version of the table includes tracked changes from the last version provided to the Steering Committee in July 2014.

Delta RMP Year 1 Monitoring Design Summary - COVER

**Table 1.** Delta RMP management and assessment questions, indicating edits to original questions and highlighting Year 1 questions.

Type	Management Questions	Mercury	Pesticides	Nutrients	Pathogens
Status & Trends	<p>Is there a problem or are there signs of a problem?</p> <p>a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta?</p> <p>b. Which constituents may be impairing beneficial uses in subregions of the Delta?</p> <p>c. Are trends similar or different across different subregions of the Delta?</p>	<ul style="list-style-type: none"> <li>• What are the status and trends in ambient concentrations of total and methylmercury (MeHg) in water and in fish, particularly in subareas likely to be affected by major sources or new sources (e.g., large-scale restoration projects)?               <ul style="list-style-type: none"> <li>○ Do trends over time in MeHg in sportfish vary among Delta subareas?</li> </ul> </li> <li>○ How are MeHg concentrations in Delta subareas associated with existing sources, activities, and events?</li> <li>○ How are concentrations affected by variability in climate, hydrology, and ecology?</li> </ul>	<ul style="list-style-type: none"> <li>• To what extent do current use pesticides contribute to observed toxicity in the Delta?               <ul style="list-style-type: none"> <li>○ Which pesticides have the highest potential to be causing toxicity in the Delta and therefore should be the priority for monitoring and management?</li> <li>○ What are the spatial and temporal extents of lethal and sublethal aquatic and sediment toxicity observed in the Delta?</li> </ul> </li> <li>• What are the spatial/temporal distributions of concentrations of currently used pesticides identified as likely causes of observed toxicity?</li> </ul>	<ul style="list-style-type: none"> <li>• How do concentrations of nutrients (and nutrient-associated parameters vary spatially and temporally?               <ul style="list-style-type: none"> <li>○ Are trends similar or different across subregions of the Delta?</li> <li>○ How are ambient levels and trends affected by variability in climate, hydrology, and ecology?</li> <li>○ Are there important data gaps associated with particular water bodies within the Delta subregions?</li> </ul> </li> <li>• What is the current status of the Delta ecosystem as influenced by nutrients?               <ul style="list-style-type: none"> <li>○ What is the current ecosystem status of habitat types in different types of Delta waterways, and how are the conditions related to nutrients?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Are current pathogen levels supportive of the municipal drinking water quality beneficial use as described in the Basin Plan?</li> </ul>

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Type	Management Questions	Mercury	Pesticides	Nutrients	Pathogens
<b>Sources, Pathways, Loadings &amp; Processes</b>	<p>Which sources and processes are most important to understand and quantify?</p> <p>a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems?</p> <p>b. What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)?</p> <p>c. What are the magnitudes of internal sources and/or pathways (e.g. benthic flux) and sinks in the Delta?</p>	<ul style="list-style-type: none"> <li>Which sources, pathways and processes contribute most to observed levels of methylmercury in fish? <ul style="list-style-type: none"> <li>What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)?</li> <li>How do internal sources and processes influence methylmercury levels in fish in the Delta?</li> <li>How do currently uncontrollable sources (e.g., atmospheric deposition, both as direct deposition to Delta surface waters and as a contribution to nonpoint runoff) influence methylmercury levels in fish in the Delta?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>What are the principal sources and pathways responsible for aquatic <a href="#">and sediment</a> toxicity observed in the Delta?</li> <li>What are the fates of prioritized pesticides <a href="#">and degradates</a> in the environment? <ul style="list-style-type: none"> <li>Do physical/chemical properties of priority pesticides, <a href="#">application rates and processes</a>, and ambient conditions influence the degree of toxicity observed?</li> </ul> </li> <li>What are the spatial/temporal use patterns of priority pesticides?</li> </ul>	<ul style="list-style-type: none"> <li>Which sources, pathways, and processes contribute most to observed levels of nutrients? <ul style="list-style-type: none"> <li>How have nutrient or nutrient-related source controls and water management actions changed ambient levels of nutrients and nutrient-associated parameters?</li> <li>What are the loads from tributaries to the Delta?</li> <li>What are the sources and loads of nutrients within the Delta?</li> <li>What role do internal sources play in influencing observed nutrient levels?</li> <li>Which factors in the Delta influence the effects of nutrients?</li> <li>What are the types and sources of nutrient sinks within the Delta?</li> <li>What are the types and magnitudes of nutrient</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Can any changes in bin level<sup>1</sup> be attributed to an identifiable event, condition, or changes in a source? <ul style="list-style-type: none"> <li>What is the influence of sources on pathogen levels at drinking water intakes?</li> <li>What is the viability and infectiousness of pathogens at drinking water intakes?</li> <li>Are there new discharges or changes in sources or conditions that could explain the change in bin level compared to previous LT2 monitoring?</li> </ul> </li> <li>What are the factors affecting decay and growth rates and can they be quantified and characterized for the purpose of modeling?</li> </ul>

<sup>1</sup> EPA has developed the Long Term 2 Enhanced Surface Water Treatment Rule (LT2 rule), which classifies filtered water systems into one of four treatment categories (bins) based on their monitoring results for *Cryptosporidium*. Most systems are expected to be classified in the lowest bin and will face no additional requirements. Systems classified in higher bins must provide additional water treatment to further reduce *Cryptosporidium* levels by 90 to 99.7 percent (1.0 to 2.5-log), depending on the bin. From: Rule Fact Sheet - Long Term 2 Enhanced Surface Water Treatment Rule (USEPA 2005).

Delta RMP Year 1 Monitoring Design Summary - COVER

Type	Management Questions	Mercury	Pesticides	Nutrients	Pathogens
				<a href="#">exports from the Delta to Suisun Bay and water intakes for the State and Federal Water Projects?</a>	
<b>Forecasting Scenarios</b>	<ul style="list-style-type: none"> <li>a. How do ambient water quality conditions respond to different management scenarios</li> <li>b. What constituent loads can the Delta assimilate without impairment of beneficial uses?</li> <li>c. What is the likelihood that the Delta will be water quality-impaired in the future?</li> </ul>	<ul style="list-style-type: none"> <li>• What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?</li> </ul>	<ul style="list-style-type: none"> <li>• How do pesticide concentrations respond to different management scenarios?</li> <li>• What current use pesticide loads can the Delta assimilate without exceeding water quality criteria established to protect beneficial uses?</li> <li>• How <a href="#">will changes in management of irrigation water due to</a> climate change affect <a href="#">loading of pesticides and impacts to sensitive species?</a></li> </ul>	<ul style="list-style-type: none"> <li>• How will ambient water quality conditions respond to potential or planned future source control actions, restoration projects, and water resource management changes?</li> </ul>	<ul style="list-style-type: none"> <li>• What is the effect of source controls on pathogen levels at drinking water intakes?</li> <li>• How will proposed restoration projects, water operations, and future urban growth affect municipal drinking water intake bin levels?</li> </ul>
<b>Effectiveness Tracking</b>	<ul style="list-style-type: none"> <li>a. Are water quality conditions improving as a result of management actions such that beneficial uses will be met?</li> <li>b. Are loadings changing as a result of management actions?</li> </ul>	<ul style="list-style-type: none"> <li>• [none]</li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Are pesticide-related toxicity impacts decreasing over time?</a></li> </ul>	<ul style="list-style-type: none"> <li>• How are eutrophication and its associated effects in Delta subareas improving as a result of nutrient source controls, such that beneficial uses are being met? <ul style="list-style-type: none"> <li>◦ <a href="#">Do we have evidence that regulation in nutrients has effects on increase in beneficial uses?</a></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• [none]</li> </ul>

### 3 Recommended Monitoring Designs

Monitoring design type refers to the general focus of how, when, and where monitoring is conducted. For Year 1, the proposed designs focus on status and trends questions. This overview document only considers the *recommended* design for each constituent. The attached four constituent monitoring design summaries provide additional options with associated costs to provide a range of designs based on available funding. The recommended designs, by constituent, are summarized below. **Figure 1** shows a map of the proposed sampling sites for each constituent and, for reference, the potential Delta RMP core sites proposed by POTWs.

#### Current Use Pesticides

##### **Water**

**Focus Sites:** Monthly sampling at five sites, which would also capture targeted events. Targeted events (n = 5/year): Wet Weather: (1) First flush, (2) Significant winter storm; Dry weather: (1) Late summer/fall irrigation season, (2) Spring runoff, (3) 2nd irrigation event (late spring/early summer). Chemical analyses and toxicity testing on all samples. Proposed test species (endpoints): (1) *Selenastrum capricornutum* (growth) (2) *Ceriodaphnia dubia* (survival and reproduction), (3) *Hyalella azteca* (survival), and (4) *Pimephales promelas* (larval survival and growth) and/or *Oncorhynchus mykiss* (larval survival). Chemistry: Pesticide scan (USGS) and dissolved copper analysis. Pesticide-focused Toxicity Identification Evaluations (TIEs) for a subset of samples with > 50% of the measured endpoint; to be decided real-time by a TIE subcommittee.

**Additional sites:** Three to four targeted sites for event-based sampling only.

##### **Sediment**

No additional monitoring in year 1. The Delta RMP will include data from the Surface Water Ambient Monitoring Program (SWAMP) Stream Pollution Trends (SPoT) monitoring (State Water Resources Control Board) in the Year 1 assessment. SPoT collects samples in the Delta region annually in late summer. SPoT toxicity test species (endpoints): (1) *Hyalella azteca* (survival), (2) *Chironomus dilutus/tentans* (survival). Chemistry: pyrethroids.

#### Mercury

##### **Sportfish**

Annual sampling is proposed in late summer to early autumn. Indicator of primary interest is methylmercury in muscle fillet of 350-mm largemouth bass (or similar predator species).

##### **Water**

Up to monthly sampling (10 months/yr., with less frequency during summer-fall). Indicator of primary interest is total methylmercury in water (measured as sum of particulate and dissolved).

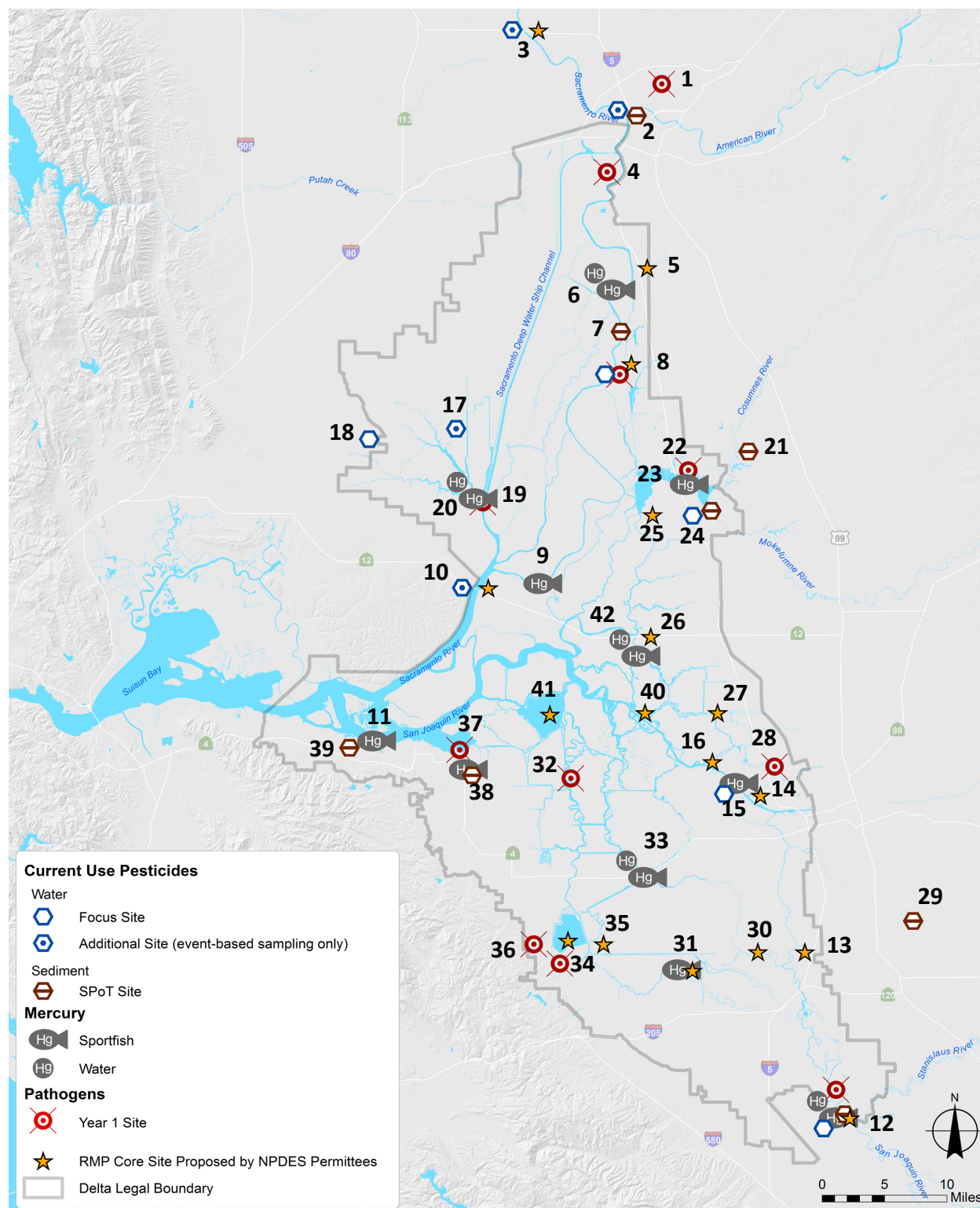
#### Nutrients

No monitoring is proposed for year 1. Instead, the RMP will synthesize and analyze existing information and data, and then design a monitoring plan based on findings by December 2015. The nutrient data analysis and monitoring plan development will be closely coordinated with the development of the Delta Nutrient Research Plan (led by the Central Valley Water Board) and ongoing funded studies that will at least partially address RMP assessment questions.

### **Pathogens**

Monthly sampling. Year one of the Pathogen Study will focus on characterizing pathogen levels (*Cryptosporidium* and *Giardia lamblia*) to address the objectives of the Pathogen Special Study required by the Central Valley Drinking Water Policy Basin Plan Amendment. The study includes monitoring at the drinking water intake locations and at ambient locations throughout the Delta. The sampling will be added to the routine monthly sampling effort of the Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI). The proposed Delta RMP contribution would be to pay for required additional laboratory analyses, data management, and reporting.

# Delta RMP Year 1 Monitoring Design Summary - COVER



**Figure 1. Proposed Delta RMP Monitoring Sites.** See Table 2 for more information.

**Table 2.** List of proposed Delta RMP sites and monitoring frequency, by constituent.

Proposed Sites	Map Key	Current Use Pesticides - Water Sampling	Current Use Pesticides - SpoT Sediment Sampling	Mercury - Sportfish	Mercury - Water	Pathogens - Year 1	Core Sites Proposed by POTWs
Colusa Basin Ag Drain	*					M	
Natomas East Main Drainage Canal	1					M	
American R @ Discovery Park	2	E	Y				
Sacramento R @ Veteran's Bridge	3	E					✓
Sacramento R @ Westin Boat Dock	4					M	
Sacramento R @ Freeport	5						✓
Sacramento R @ RM44	6			Y	M[10]		
Sacramento R @ Clarksburg Marina	7		Y				
Sacramento R @ Hood	8	M				M	✓
Sacramento R nr Isleton	9			Y			
Sacramento R @ Rio Vista	10	E					✓
Sherman Lake	11			Y			
San Joaquin R @ Vernalis/Airport Way	12	M	Y	Y	M	M	✓
San Joaquin R @ Brandt Br	13						✓
San Joaquin R @ Rough & Ready Island	14						✓
San Joaquin R @ Buckley Cove	15	M		Y			
San Joaquin R @ Rindge Pump	16						✓
Shag Sl @ Liberty Island Bridge	17	E					✓
Ulati C @ Brown Rd	18	M					
Liberty Island south	19					Monthly	
Liberty Island	20			Y	M[10]		
Cosumnes R @ Twin Cities Rd	21		Y				

# Delta RMP Year 1 Monitoring Design Summary - COVER

Proposed Sites	Map Key	Current Use Pesticides - Water Sampling	Current Use Pesticides - SpoT Sediment Sampling	Mercury - Sportfish	Mercury - Water	Pathogens - Year 1	Core Sites Proposed by POTWs
Mokelumne R @ Benson Ferry	22					M	
Mokelumne R ds Cosumnes R	23			Y			
Mokelumne R @ New Hope Road	24	M	Y				
Mokelumne R, South Fork	25						✓
Mokelumne R, South Fork @ Staten Island	26						✓
Disappointment Slough @ Bishop Cut	27					M	
Calaveras R @ UoP Footbridge	28					M	
Lone Tree C @ Austin Rd	29			Y			
Old R nr Middle R	30			Y			✓
Old R @ Tracy Rd Br	31						✓
Old R @ Bacon Island	32					M	
MID flux station	33			Y	M[10]		
Jones Pumping Plant	34					M	
Mendota Canal Headworks	35						✓
Banks Pumping Plant	36					M	✓
Rock Slough @ CCWD Fish Facility	37					M	
Marsh C	38		Y	(Y)			
Kirker C @ Floodway	39		Y				
City of Stockton, Delta Water Supply Intake	40			Y	M[10]		
Frank's Tract	41						✓
Little Potato Slough	42			Y	M[10]		

\*outside of map area; M = Monthly, M[10] = monthly (10 months/year); Y = Yearly, E = Events only

## 4 Coordination Opportunities

One of the next steps in finalizing the monitoring plan will be the identification and recommendation of specific opportunities for sampling coordination. This step will involve both internal coordination (e.g., efficiencies among individual constituent monitoring designs) and external coordination (e.g. “piggybacking” onto other programs).

The potential for sampling coordination or consolidation and associated cost-savings is more significant for sampling efforts that are more frequent and less specialized than for sampling efforts that are less frequent and require highly specialized equipment and techniques. Examples for more frequent sampling efforts requiring little specialized equipment or techniques are the collection of water grab samples for analyses of pathogens or pesticides. An example for a very specialized sampling effort is the collection of cross-sectional water samples employing ultra-clean techniques for methylmercury analyses.

Coordination opportunities could be realized by a) co-locating sites or consolidating sampling sites that are in close proximity to each other and provide similar information, b) timing routine sampling schedules such that they cover desired events, and c) collaborative agreements with existing program that sample at sites of interest or nearby or who may be willing to add certain sites to their existing monitoring schedule (and time their sampling such that it would cover desired events).

Specific steps will involve to 1) identify and recommend specific opportunities for sampling coordination (TAC and ASC), negotiate collaborative sampling arrangements (SC), and 3) coordination planning (ASC).

Potential partners for sampling coordination (Year 1 implementation) have been identified and include the Interagency Ecological Program (DWR Environmental Monitoring Program), DWR MWQI, U.S. Geological Survey, the Sacramento River Coordinated Monitoring Program, SWAMP, the Sacramento Valley Water Quality Coalition, POTWs (Regional San, Stockton, Tracy, Rio Vista), and stormwater programs (Sacramento, Stockton, Port of Stockton).

## 5 Schedule

A preliminary proposed five-year schedule for the Delta RMP is shown in **Table 3**. Current planning activities focus heavily on the Year 1 monitoring design. ASC will develop a multi-year program plan by the end of 2015.

**Table 3.** Proposed, preliminary five-year schedule for the Delta RMP.

	2015				2016				2017				2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>1. Program management</b>																				
a. ASC contract																				
b. Coordination of program activities																				
c. Contract and fiscal management																				
d. Peer review																				
e. Program planning																				
f. Program planning - Multi-year program plan																				
<b>2. Governance</b>																				
a. SC and subcommittees																				
b. TAC and subcommittees																				
c. RMP website																				
d. Annual meeting																				
<b>3. Communications</b>																				
a. Communication plan																				
b. Communications product - decide content																				
c. Communications product - develop content																				
d. Communications product - release																				
<b>4. Data management</b>																				
a. Training and technical support																				
b. Data processing and uploading																				
c. Data transfer to CEDEN																				
d. Implement/maintain infrastructure and procedures																				
e. QAPP																				
<b>5. Status &amp; Trends</b>																				
a. Current Use Pesticides: Year 1 monitoring																				
b. Current Use Pesticides: Year 2+ design																				
c. Current Use Pesticides: Year 2+ monitoring																				
d. Mercury: annual sportfish sampling																				
e. Mercury: monthly (10 mo./yr) water sampling																				
f. Nutrients: phased implementation																				
<b>6. Special studies</b>																				
a. Nutrients: monitoring program development																				
b. Nutrients: Year 1 data synthesis																				
c. Pathogens: Year 1 (monthly water intake sampling)																				
d. Pathogens: Year 1 data evaluation/Year 2 study design																				
e. Pathogens: Year 2 (monthly water intake sampling)																				
f. Pathogens: data analyses and report																				

**Key:**

Deliverables

Activity

## 6 Budget Estimate

**Table 4** provides a preliminary program budget estimate that is based on the recommended Year 1 designs for each constituent. The table also includes preliminary cost estimates for program management, governance, communications, and data management. To some extent, those overall components scale relative to the level of effort of proposed monitoring and special studies. However, they would decrease less than proportionally if the level of effort is reduced.

The budget estimate does not yet factor in potential cost savings that could be achieved through sampling coordination, “piggybacking”, or no-cost in-kind contributions.

**Table 4.** Preliminary 2015 budget estimate for the Delta RMP.

<b>1. Program management</b>	<b>\$ 85,000</b>
a. ASC contract	\$ 10,000
b. Coordination of program activities	\$ 30,000
c. Contract and fiscal management	\$ 15,000
d. Peer review	\$ -
e. Program planning - Multi-year program plan	\$ 30,000
<b>2. Governance</b>	<b>\$ 160,000</b>
a. SC and subcommittees	\$ 75,000
a. TAC and subcommittees	\$ 80,000
c. RMP website	\$ 5,000
d. Annual meeting	\$ -
<b>3. Communications</b>	<b>\$ 36,000</b>
a. Communication plan	\$ 20,000
b. Communications product - decide content	\$ 3,000
c. Communications product - develop content	\$ 3,000
d. Communications product - release	\$ 10,000
<b>4. Data management</b>	<b>\$ 198,000</b>
a. Training and technical support	\$ 28,000
b. Data processing and uploading	\$ 100,000
c. Data transfer to CEDEN	\$ 25,000
d. Implement/maintain infrastructure and procedures	\$ 15,000
e. QAPP	\$ 30,000
<b>5. Status &amp; Trends</b>	<b>\$ 706,000</b>
a. Current Use Pesticides: Year 1 monitoring	\$ 480,000
b. Current Use Pesticides: Year 2+ design	\$ 15,000
c. Current Use Pesticides: Year 2+ monitoring	\$ -
d. Mercury: annual sportfish sampling	\$ 73,000
e. Mercury: monthly (10 mo./yr.) water sampling	\$ 138,000
f. Nutrients: phased implementation	\$ -
<b>6. Special studies</b>	<b>\$ 297,000</b>
a. Nutrients: monitoring program development	\$ 125,000
b. Nutrients: Year 1 data synthesis	\$ 100,000
c. Pathogens: Year 1 (monthly water intake sampling)	\$ 72,000
c. Pathogens: Year 1 data evaluation/Year 2 study design	\$ -
d. Pathogens: Year 2 (monthly intake sampling)	\$ -
f. Pathogens: data analyses and report	\$ -
<b>TOTAL PROPOSED COST</b>	<b>\$ 1,482,000</b>
ASC Contract Balance (estimated)	\$ 106,000
<b>Additional Funding Needed (estimated)</b>	<b>\$ 1,376,000</b>

## 7 Next Steps

With funding and approval by the Steering Committee, the TAC and ASC will move forward with completing the monitoring program design for year 2015. Consistent points made by the constituent subcommittees for next steps towards developing those designs include:

- Scale monitoring design to match Steering Committee interests and available budget
- Coordinate with potential monitoring partners
- Develop an overall program management plan (fieldwork and data management; reporting; contracting and bookkeeping, schedule)

**Table 6.** Next steps in program development.

<b>Program Development Task</b>	<b>Information out (anticipated date)</b>	<b>Responsibility</b>	<b>Input (anticipated date)</b>	<b>Who Responsible</b>
Collaboration opportunities	Recommended coordination efficiencies (November 31)	TAC	Explore coordination opportunities (November 31)	TAC TAC subcommittees ASC
Monitoring Plan	Draft Monitoring Plan (December 31) Final Draft Monitoring Plan (January 31)	ASC	Comments (December 22)  (January 21)	SC TAC
Logistical and cost-sharing arrangements	Coordination proposal (January 2)	ASC, TAC, SC, Regional Board	Formalize logistical and cost-sharing arrangements (February 2)	Delta RMP participants
Monitoring and assessment coordination agreements	Coordination proposal (January 2)	ASC Regional Board	Formalize coordination arrangements (February 2)	Delta RMP participants
Data management	Recommend procedures (June 30, 2015)	TAC	Implement procedures (July 2015)	ASC, Delta RMP participants, data generators (labs)

## Monitoring Design Summary – Current Use Pesticides

### ***Year 1 Monitoring Questions***

The initial Delta RMP priority for current use pesticides is to address the overall Management Question:

*Is there a problem or are there signs of a problem?*

S&T 1. To what extent do current use pesticides contribute to observed toxicity in the Delta?

S&T2.1. Which pesticides have the highest potential to be causing toxicity in the Delta and therefore should be the priority for monitoring or management?

- A. If samples are toxic, do detected pesticides explain the toxicity?
- B. If samples are not toxic, do detected pesticide concentrations exceed other thresholds of concern (e.g., water quality objectives or Office of Pesticide Programs aquatic toxicity benchmarks)?

S&T2.2. What are the spatial and temporal extents of lethal and sublethal aquatic and sediment toxicity observed in the Delta?

- A. Do aquatic or sediment toxicity tests at targeted sites indicate a toxic response?
- B. If answer to A is yes, which other toxicity indicator(s) should guide monitoring and management of pesticides in Years 2+?

S&T 2. What are the spatial/temporal distributions of concentrations of current use pesticides identified as likely causes of observed toxicity?

S&T2.1. Which pesticides have the highest risk potential (based on DPR's risk prioritization model<sup>2</sup>) and should be included in chemical analyses?

- A. Is the list of pesticides included in USGS pesticide scan sufficient for Delta RMP monitoring design?
- B. Are methods available to monitor pesticides with high-risk potential not included in USGS pesticide scan?

S&T2.2. How do concentrations of the pesticides with the highest risk potential vary seasonally and spatially?

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<sup>2</sup> [http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis\\_memos/prioritization\\_report\\_2.pdf](http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/prioritization_report_2.pdf)

### **Water Sampling**

- ⇒ Toxicity testing for all samples - Proposed test species (endpoints):
  - *Selenastrum capricornutum* (growth)
  - *Ceriodaphnia dubia* (survival and reproduction)
  - *Hyalella azteca* (survival)<sup>3</sup>
  - *Pimephales promelas* (larval survival and growth) and/or *Oncorhynchus mykiss* (larval survival).
- ⇒ Chemistry for all samples:
  - Pesticide scan (USGS)
    - All samples
    - Add additional high-risk “indicator” pesticides (based on DPR’s risk prioritization model) as analytes if they are not currently included in USGS pesticide scan.
  - Dissolved copper<sup>4</sup>
  - Field measurements and general water quality measurements (alkalinity, ammonia, DO, EC, hardness, pH etc.) as part of routine toxicity testing
  - Based on need and availability, monitoring data for additional constituents that may influence any observed toxicity would be gleaned from other Delta RMP modules or other programs
- ⇒ Pesticide-focused TIEs for samples with  $\geq 50\%$  of the measured endpoint (not to exceed 20% of samples or \$40,000)
- ⇒ Frequency: monthly sampling at baseline sites and targeted events-based sampling at additional “targeted” sites

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<sup>3</sup> According to: USEPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. Office of Water, Washington, DC. EPA/821/R-02/012. The SWAMP QAPP specifies Measurement Quality Objectives for this method ([http://www.waterboards.ca.gov/water\\_issues/programs/swamp/docs/mqo/15\\_acute\\_toxicity.pdf](http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/mqo/15_acute_toxicity.pdf)).

<sup>4</sup> Copper is at the same time a critical micronutrient involved in many metabolic processes in living organisms and a ubiquitous surface water pollutant that causes a range of adverse acute, chronic, and sublethal effects in fish as well as in aquatic invertebrates and algae (Hansen et al., 1999; Baldwin et al., 2003; Sandahl et al., 2004). These effects are relevant to threatened and endangered salmonids in California’s Central Valley considering copper’s use as a pesticide. For example, copper sulfate pentahydrate is used extensively on rice to control tadpole shrimp. From 1991 to 1996 the use of this active ingredient increased almost threefold to 2,987,034 pounds/year applied. Of the approximately 3 million pounds that were applied in 1996, 91.4% was applied to rice (CDPR, 1999). Copper sulfate pentahydrate use has continued to increase with 3,675,045 lbs. applied in 2004 (CDPR, 2004). It can be applied by both aerial and ground application methods. Due to the sensitivity of salmonid sensory systems, the ecological significance of their impairment, and the documented presence of elevated concentrations of dissolved copper in salmonid habitats; it is critical to determine exposure concentrations and durations that adversely affect salmonids.

⇒ Targeted events (n = 5/year):

- Wet Weather: (1) First flush, (2) Significant winter storm
- Dry weather: (1) Late summer/fall irrigation season, (2) Spring runoff, (3) 2nd irrigation event (late spring/early summer)
- Monthly sampling at baseline sites would capture targeted events

### ***Budget Estimate***

Component	Water Sampling	
	Reduced (Recommended)	Higher-range
<b>Design</b>	Hybrid Approach  5 baseline sites plus 3-4 sites targeted for event-based sampling	High frequency, high intensity  18 baseline sites
<b>Frequency</b>	Baseline sites: monthly Targeted-events sites: 5 events	Monthly
<b>Toxicity</b>	All samples	All samples
<b>Chemistry</b>	All samples	All samples
<b>Pesticide-focused TIEs</b>	Not to exceed \$40,000	Up to 20% of samples found >50% toxic for at least one endpoint
<b>Coordination</b>	USGS, IEP-EMP, monthly receiving water monitoring (ILRP, NPDES), SWAMP, stormwater programs	USGS, IEP-EMP, monthly receiving water monitoring (ILRP, NPDES), SWAMP, stormwater programs
<b>Unit Cost</b>	\$6,000/site-event	\$6,000/site-event
<b>Annual Cost</b>	\$480,000	~\$1.3M/year for 18 sites

### **Assumptions for estimating costs per site per event:**

- Toxicity testing:
  - o 3 freshwater test species with a site water vs. a control (\$1,542)
  - o 96hr survival test with *Hyaella azteca* (\$800)
- USGS pesticide scan (~\$2,060/analysis)
- Copper analysis (\$29)
- Add 20% to total for QA/QC and lab reporting

## Delta RMP Year 1 Monitoring Design Summary – CURRENT USE PESTICIDES

- Pesticides-focused TIEs (5 manipulation test including 8 treatments) = \$2,700/test
- ~20% of events/sites assumed <50% toxic response for at least one endpoint  
=>TIEs at 20% of sites
- Sampling assumes:
  - o 12 hr. field day for each event
  - o Each field crew would cover at least 7 sites/event
  - o 2 hrs prep and follow up/event (1 staff) = \$200
  - o Labor: \$100/hr.; 2 field staff
  - o Driving per event: 200 miles x 0.7/mile = \$140/event
  - o Add some buffer

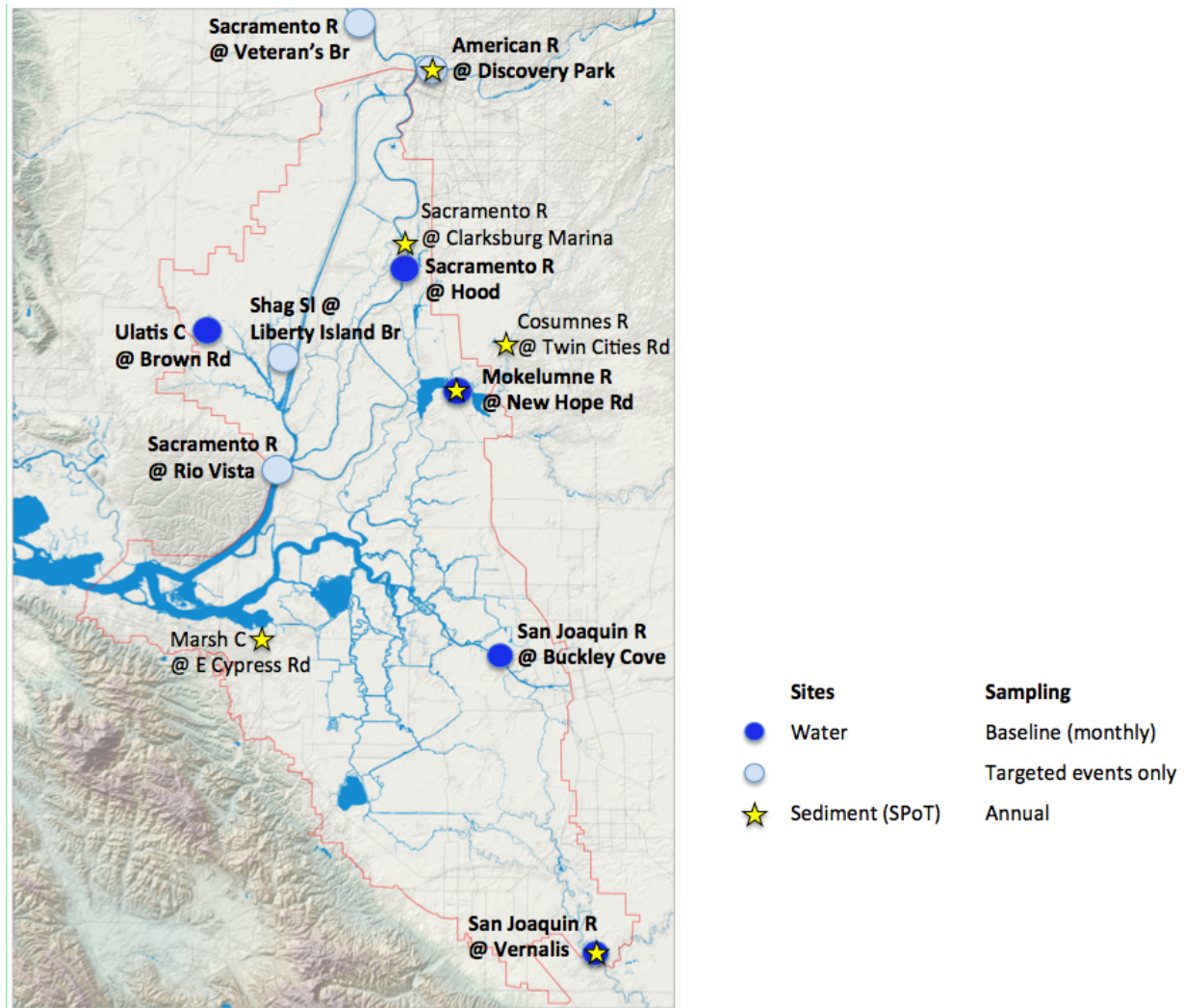
### ***Sediment Sampling***

The following monitoring conducted by SWAMP Stream Pollution Trends (SPoT) monitoring program will be incorporated into the analysis of current use pesticide effects in the Delta.

- ⇒ Toxicity testing:
  - *Hyalella azteca* (survival)
  - *Chironomus dilutus/tentans* (survival)
- ⇒ Chemistry:
  - Pyrethroids
  - Field measurements and general water quality measurements (temperature, DO, EC, pH etc.) as part of routine toxicity testing
- ⇒ Events:
  - Late summer

Component	Sediment Sampling Recommended: All in-kind
Design	6 sites
Frequency	1 event
Toxicity	All samples
Chemistry	All samples
Coordination	SPoT does all sampling, toxicity testing, and chemical analyses
Unit Cost	n/a
Annual Cost	No additional investment by Delta RMP

## Proposed Monitoring Sites



Note: Sediment sampling sites are selected by SPoT at representative sites with sediment deposition. They do not all overlap with water sampling sites.

# Delta RMP Year 1 Monitoring Design Summary – CURRENT USE PESTICIDES

## Current Use Pesticide and Toxicity Monitoring Sites

Proposed Sites	Water - Baseline	Water - Targeted Events Only	Sediment (SPoT)*	Reason for selection
American River @ Discovery Park		X	X	Integrator Site: American R watershed. Proposed RMP core site
Marsh C @ E Cypress Crossing (Brentwood)			X	Represents Marsh Creek influence (urban and ag/orchards).
Mokelumne R @ New Hope Rd	X		X	Indicator site for tributary influences at eastside boundary, Geographic gap/ watershed influence is mostly ag dominated
Sacramento R @ Clarksburg Marina			X	SPoT site: in-kind sampling and toxicity testing. Integrator Site/key inflow: Sac R watershed ds of Sac urban area; proposed RMP core site; SPoT site
Sacramento R @ Hood	X			Integrator Site/key inflow: Sac R watershed ds of Sac urban area; proposed RMP core site
Sacramento R @ Rio Vista		X		Integrator site: Sac River ds of Yolo Bypass, Sac R/DWSC confluence, and in-Delta contributions
Sacramento R @ Veteran's Bridge		X		Integrator site/key inflow: Sac R upstream of Sacramento urban area
San Joaquin R @ Buckley Cove	X		X	Integrator site: SJR mainstem ds of Stockton urban area; proposed

Delta RMP Year 1 Monitoring Design Summary – CURRENT USE PESTICIDES

Proposed Sites	Water - Baseline	Water - Targeted Events Only	Sediment (SPoT)*	Reason for selection
				RMP core site
San Joaquin R @ Vernalis	X		X	Integrator site/key inflow: SJR watershed upstream of Delta boundary. Proposed RMP core site.
Shag Slough @ Liberty Island Bridge		X		Ecological significance of Cache/Prospect Slough complex. Ag and urban influences ds of Yolo Bypass. SVWQC site.
Ulati C @ Brown Rd	X			Indicator site: Yolo Bypass site representing Cache/Prospect Slough Complex

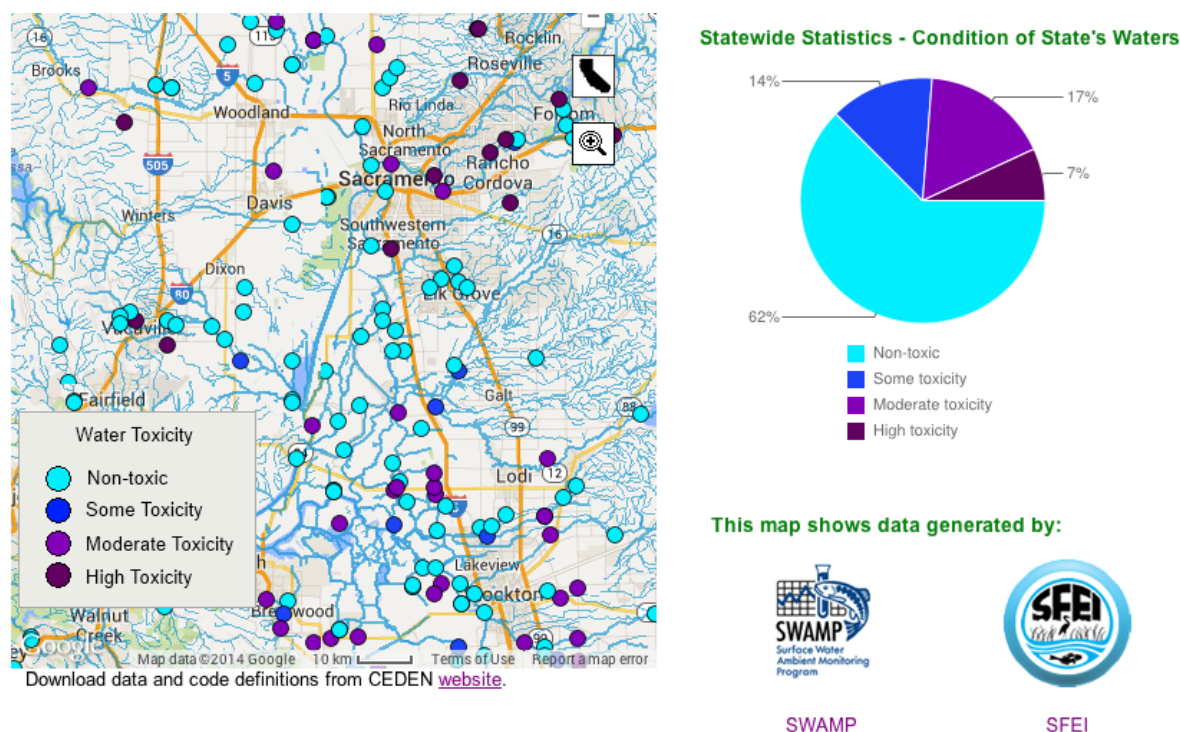
\*In-kind by State Water Board SWAMP.

## Data Products

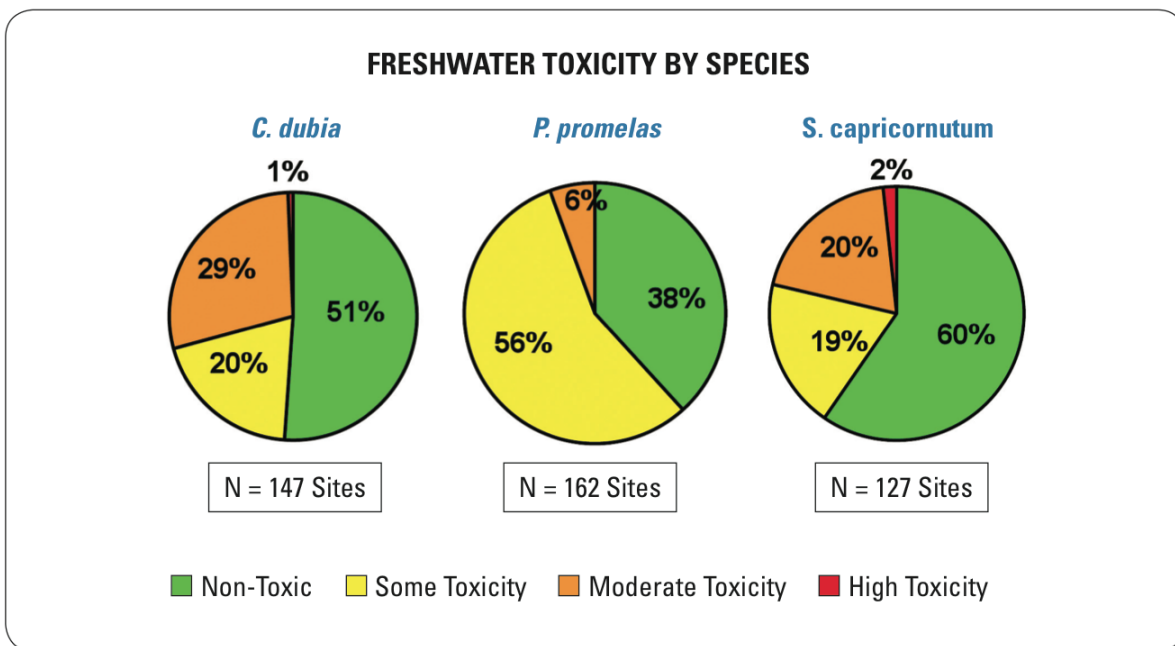
### *Pesticides with the highest risk potential*

- ⇒ Prioritized list of pesticides, based on results from DPR's risk prioritization model.
- ⇒ See Luo et al. (2014): [Methodology for Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas II: Refined Priority List](#).
- ⇒ Use of results: refine chemical and toxicity monitoring design

### *EXAMPLE: Magnitude of water (sediment) toxicity observed at Delta sampling sites*



**Figure a.** Example of a color-coded map of sites (e.g. gradient): cyano = non-toxic blue = some, indigo = moderate, maroon = highly toxic. Annual averages at each site. Categories: Non-toxic = no toxicity detected at site; some toxicity = all samples below high-toxicity threshold; moderate toxicity = mean for all samples less toxic than high-toxicity threshold; high toxicity = mean for all samples more toxic than high-toxicity threshold. High toxicity thresholds specific to each test endpoint are calculated according to [Bay et al. \(2007\)](#).



**Figure 2.** Magnitude of toxicity to individual freshwater species in water samples from the Central Valley Region of California.

**Figure b.** Example for graphic summary of results for magnitude of toxicity by species/endpoint in water (sediment) samples from the Delta (site x,y,z/flowpath), all data for monitoring year XX.

#### *Toxicity trends (Year 2+)*

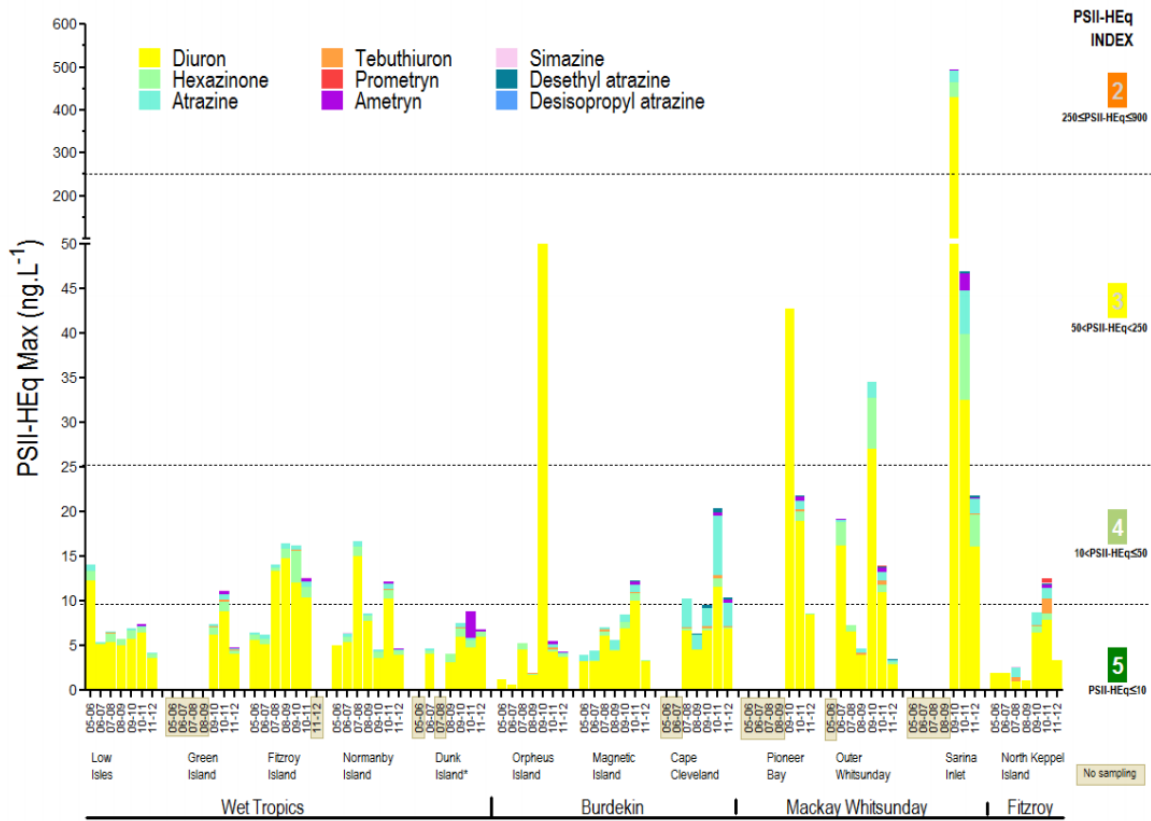
Example: SPoT sediment toxicity trends in tests conducted at 23 °C from 2008-2012 (potentially to provide in graph form).

	2008	2009	2010	2011	2012
Number of Sites Tested	92	23	95	100	100
% Non-toxic	83	74	81	85	82
% Toxic	11	17	11	10	9
% Highly Toxic	6	9	8	5	9
% Toxic + % Highly Toxic	17	26	19	15	18

⇒ **Use of toxicity trends results** (in context of existing literature): Inform success of toxicity reduction efforts over time.

*EXAMPLE: Variation in pesticide exposure*

Variation in pesticide exposure between sampling events for stations a, b, c,...., grouped by flowpath/watershed/subregion





## Monitoring Design Summary – Mercury

### Initial Monitoring Questions

S&T 1. What are the status and trends in ambient concentrations of methylmercury and total mercury in sport fish and water, particularly in subareas likely to be affected by major existing or new sources (e.g., large-scale restoration projects)?

- A. Do trends over time in methylmercury in **sport fish** vary among Delta subareas?
- B. Do trends over time in methylmercury in **water** vary among Delta subareas?

The monitoring design focuses on the two bolded elements.

### *Fish Sampling*

- ⇒ Indicator of primary interest is methylmercury in muscle fillet of 350-mm largemouth bass (or similar predator species). Methylmercury in muscle fillets of other TL3 and TL4 species<sup>5</sup> are Indicators of secondary interest.
- ⇒ Budget estimates do not include data management, QA, and reporting.

<b>Funding Level Design</b>	<b>Lower - Recommended</b> 10 fixed sites, bass only	<b>Higher</b> 10 fixed sites and 10 random draw, bass only
<b>Frequency</b>	Annual	Annual
<b>Schedule</b>	Year 1, continue for 10 years but evaluate annually. Sample in summer or early fall.	Year 1, continue for 10 years but evaluate annually. Sample in summer or early fall.
<b>Co-location</b>	<ul style="list-style-type: none"> <li>– Water Hg (selected sites)</li> <li>– Other water parameters (selected sites)</li> </ul>	<ul style="list-style-type: none"> <li>– Water Hg (selected fixed sites only)</li> <li>– Other water parameters (selected fixed sites)</li> </ul>
<b>Coordination</b>	None	None
<b>Unit Cost:</b>	\$7,300/site-yr (\$7000 per year bass only; include other TL4 and TL3 species once every 5 years @\$8500 per site)	\$7,000/site-yr
<b>Annual Cost</b>	\$73,000	\$140,000

<sup>5</sup> The Delta Hg TMDL considers compliance based on many species which could be caught in the Delta. Trophic Level 4: bass (largemouth and striped), channel and white catfish, crappie, and Sacramento pike minnow; Trophic Level 3: American shad, black bullhead, bluegill, carp, Chinook salmon, red ear sunfish, Sacramento blackfish, Sacramento sucker, and white sturgeon.

**Water Sampling**

- ⇒ Indicator of primary interest is total methylmercury in water (measured as sum of particulate and dissolved).
- ⇒ Important ancillary parameters include particulate and dissolved total Hg, nutrients (ALK, NH<sub>3</sub>, CL, DOC, HARD, NO<sub>3</sub>/NO<sub>2</sub>, N (total), OPO<sub>4</sub>, TPHOS, SiO<sub>2</sub>, SO<sub>4</sub>, SSC, TDS, TOC), chlorophyll, DOC, grain size, suspended sediment, POC. Budget assumes nutrients covered by other funds; other parameters covered by budget in table below.
- ⇒ Budget estimates do not include data management, QA, and reporting.

<b>Funding Level</b>	<b>Lower</b>	<b>Mid-range - Recommended</b>	<b>Higher</b>
<b>Design</b>	5 fixed sites	5 fixed sites	5 fixed sites
<b>Frequency</b>	Monthly	10 months/year*	Monthly
<b>Schedule</b>	Year 1, continue for 5 years and then re-evaluate	Year 1, continue for 5 years but evaluate annually	Year 1, continue for 5 years but evaluate annually
<b>Co-location</b>	<ul style="list-style-type: none"> <li>– Sport fish sampling</li> <li>– Other water parameters</li> </ul>	<ul style="list-style-type: none"> <li>– Sport fish sampling</li> <li>– Other water parameters</li> </ul>	<ul style="list-style-type: none"> <li>– Sport fish sampling</li> <li>– Other water parameters</li> </ul>
<b>Coordination</b>	<b>Assumes sampling provided in-kind</b>	None - Sampling conducted by DRMP	None - Sampling conducted by DRMP
<b>Unit Cost:</b>	\$1150/site-month; \$5,750/month for the 5 sites	\$2750/site-month; \$13,750/month for the 5 sites	\$2750/site-month; \$13,750/month for the 5 sites
<b>Annual Cost</b>	\$69,000	\$138,000	\$165,000

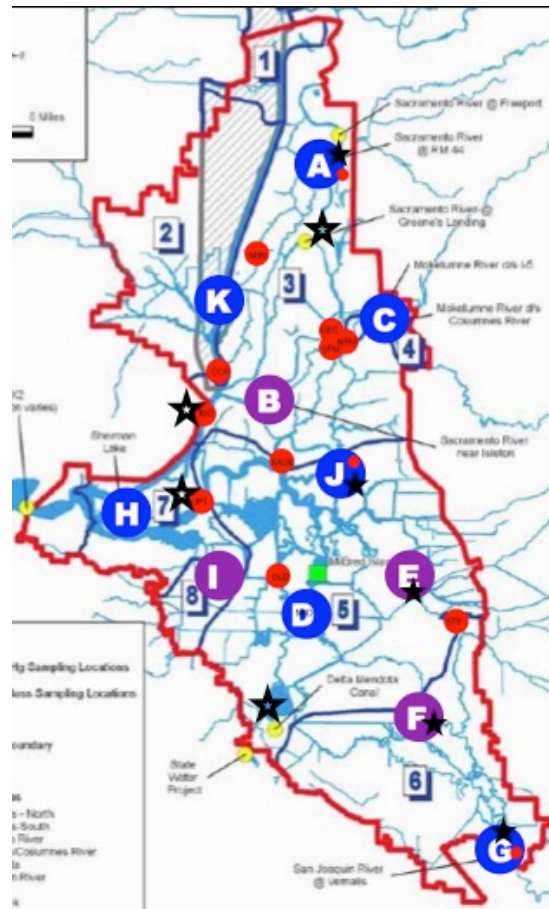
\* Samples could be distributed farther apart in time than monthly during summer-fall when conditions change less and less rapidly.

## Monitoring Sites

Monitoring sites were selected based on expert opinion considering multiple factors:

- Existing long-term datasets on which to build
- Spatial distribution, especially relative to Delta Hg TMDL subareas
- Representative inflows and outflows
- Proximity to major wetland restoration areas
- Existing monitoring by others, particularly USGS and discharge permittees
- Accessibility and popularity (such as for fishing)
- 

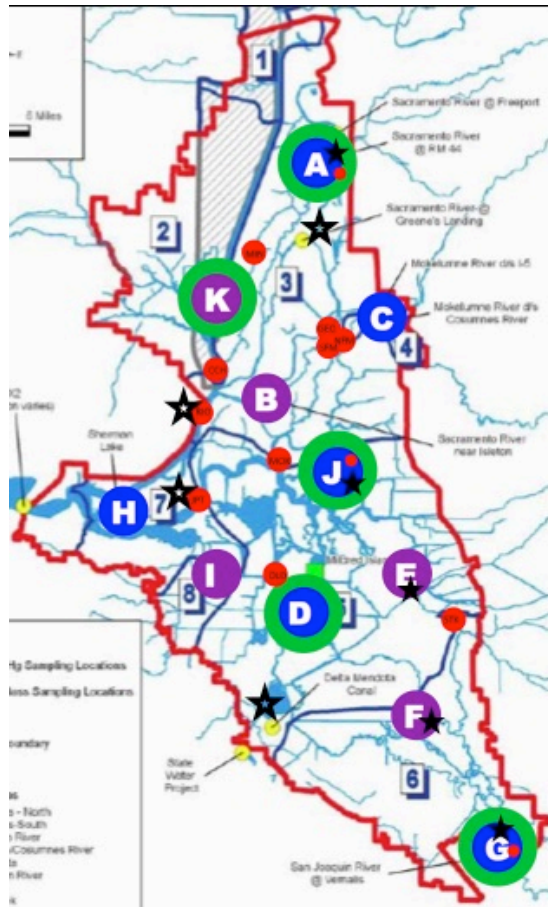
### Sampling Site Maps for Fish and Water



### Proposed Sites for Sport Fish Sampling

DWR/USGS Flux Sites ●●  
 Permittee Proposed Sites ★★  
 Proposed Fish Sites J  
 Tentative Fish Sites J

A	Sacramento R @ RM44
B	Sacramento R nr Isleton (see if redundant with J)
C	Mokelumne R ds Cosumnes R
D	MID flux station (close to Middle R at Hwy 4 fish station)
E	San Joaquin R @ Buckley Cove (keep one of E and F)
F	Old R near Middle R (keep one of E and F)
G	San Joaquin R @ Vernalis
H	Sherman Lake
I	Marsh Creek - lower priority - check on Corps
J	Little Potato Slough
K	Liberty Island - see if we can get fish



## Proposed Sites for Water Sampling

- DWR/USGS Flux Sites ●●
- Permittee Proposed Sites ★★
- Proposed Fish Sites J
- Tentative Fish Sites J

A	Sacramento R @ RM44
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G	San Joaquin R @ Vernalis
H	Sherman Lake
I	Marsh Creek - lower priority - check on Corps
J	Little Potato Slough
K	Liberty Island - see if we can get fish

## Data Products

These data products will connect directly to assessment questions S&T 1 A and B by comparing trends among sites.

### *Methylmercury in Sport Fish*

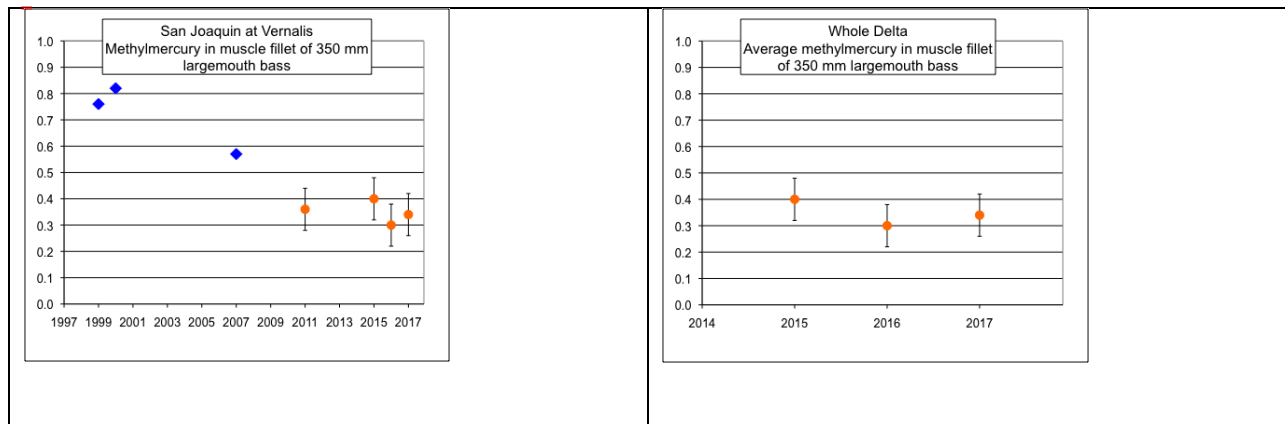


Figure 1. Annual average tissue THg concentrations for largemouth bass at the San Joaquin River at Vernalis. Historical data shown in blue; Delta RMP data shown in orange. Diamonds represent averages based on ANCOVA-generated estimates for a standard size of 350 mm<sup>6</sup>. Error bars represent 95% confidence intervals of the mean. Red line [not shown in these examples] indicates 0.24 ppm water quality objective for trophic level 4 fish.

Figure 2. Annual average tissue THg concentrations for largemouth bass in the Delta. Diamonds represent averages across stations based on ANCOVA-generated estimates for a standard size of 350 mm. Error bars represent 95% confidence intervals of the mean. Red line indicates 0.24 ppm water quality objective for trophic level 4 fish.

<sup>6</sup> This size was initially selected in the CALFED Mercury Project in 2000. It is in the middle of the size range of largemouth that are commonly and legally caught.

## Water Sampling

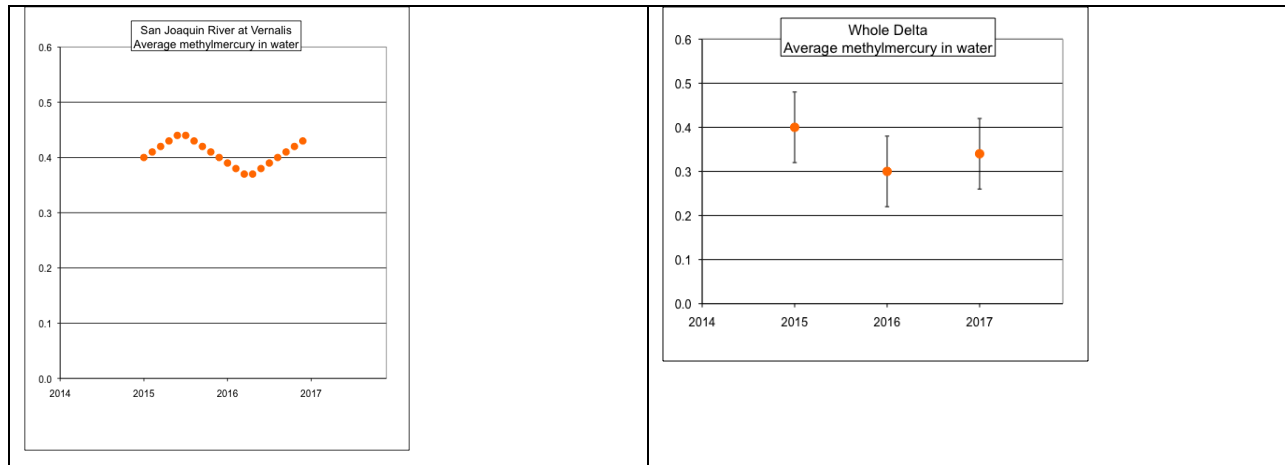


Figure 3. Unfiltered methylmercury concentrations in water at the San Joaquin River at Vernalis. Diamonds represent monthly observations. Red line indicates 0.06 ng/L implementation goal for the TMDL.

Figure 4. Annual average unfiltered methylmercury concentrations in water in the Delta. Diamonds represent monthly observations. Error bars indicate 95% confidence interval for the mean. Red line indicates 0.06 ng/L implementation goal for the TMDL.

## Near-term Development Plans

- ⇒ The preliminary sampling plan is essentially complete for now. Further development will occur if the Steering Committee decides to move forward with this work.
- ⇒ If the SC decides to move forward:
  - Develop consistent map sets for placeholder above.
  - Find out whether the US Army Corps of Engineers is monitoring sport fish in Marsh Creek (TMDL Subarea 8).
  - Decide whether to keep both fish sites B and J based on logistical constraints and available funds. Based on existing fish mercury data, they are quite different, and representative of the two different rivers.
  - Coordinate with potential monitoring partners.

## Monitoring Design Summary – Nutrients

The recommended approach for nutrients is to support and build upon other ongoing activities, which will provide a comprehensive knowledge base for nutrients in the Delta. Year 1 efforts focus on a) synthesis and analysis of existing information and data and b) development of the Delta RMP nutrient monitoring design. The planned data synthesis activities will serve to:

1. Improve our understanding of the spatial and temporal distribution of nutrients and nutrients-associated parameters in the system, and
2. Glean monitoring development needs.

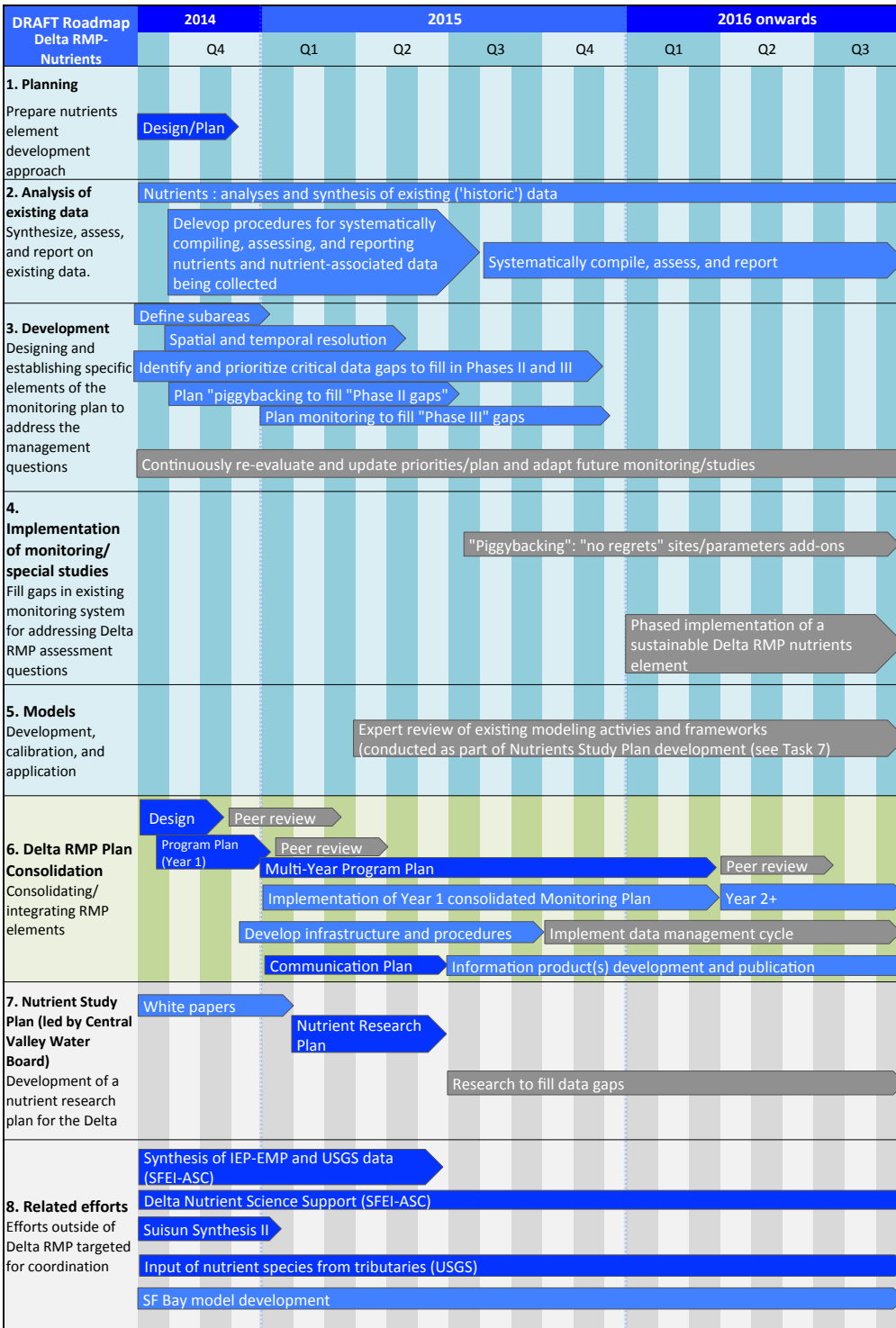
The Delta RMP nutrient monitoring and assessment plan will be produced at the end of Year 1. Costs for a longer-term monitoring design will be developed then.

### ***Activities (2014/15)***

- 1. Synthesize and analyze existing information and data.**
  - a. Synthesize and analyze existing data
- 2. Develop nutrient monitoring design.**
  - a. Establish meaningful subregions and subregion\*habitat combinations
  - b. Define sampling frame (habitats, subareas)
  - c. Data evaluation and reconciliation
  - d. Complete and vet monitoring and design proposal
  - e. Develop mechanisms for systematically compiling, assessing, and reporting data
  - f. Develop plans to fill specific data gaps
- 3. Coordinate with development of the Delta Nutrient Research Plan and other SFEI-ASC Delta nutrients work.**
  - a. Review and evaluation of results from initial Nutrient Research Plan white papers
  - b. Coordinate next steps

## Roadmap for Developing and Implementing the Delta RMP Nutrients Element

BLUE	Delta RMP: Nutrients Element	Not yet funded
GREEN	Delta RMP: larger program	Partially funded
GREY	Efforts outside of Delta RMP targeted for coordination	Funded



**Assessment Questions for Nutrients**

- Focus questions for 2014/15

Assessment Questions	Subordinate Assessment Questions (if applicable)	Detailed Monitoring Questions/Assessment Objectives
<b>Status and Trends</b>		
S&T 1. How do concentration of nutrients (forms of dissolved and total N and P) and nutrient associated parameters (chlorophyll-a, dissolved oxygen fluctuations) vary spatially and temporally?	<p>S&amp;T 1.1. Are trends similar or different across subregions of the Delta?</p> <p>S&amp;T 1.3. Are there important data gaps associated with particular water bodies within the Delta subregions?</p>	<p>A-F. What are the ranges in Delta subareas in NH<sub>4</sub>, NO<sub>3</sub>, DIN, TDN, and PO<sub>4</sub>, chl-a, and DO?</p> <p>A1, A2, A3, B1, B2, B3 etc: What is the temporal (seasonal, interannual, and decadal) and spatial variability in NH<sub>4</sub>, NO<sub>3</sub>, DIN, TDN, and PO<sub>4</sub>, chl-a, and DO?</p>
<i>S&amp;T2. What is the current status of the Delta ecosystem as influenced by nutrients?</i>	<i>S&amp;T 2.1 What is the current ecosystem status of habitat types in different types of Delta waterways, and how are the conditions correlated to nutrients?</i>	<i>Coordination with Delta Nutrient Research Plan Science Workgroups and results from initial white papers (due Spring 2015) will inform the development of more specific objectives</i>
<b>Sources, Pathways, Loadings, and Processes</b>		
SPLP 1. Which sources, pathways, and processes contribute most to observed levels of nutrients?	SPLP 1.1. How have nutrient- or nutrient-related source controls and water management actions changed ambient levels of nutrients and nutrient-associated parameters?	<ul style="list-style-type: none"> <li>• Use mass-balance approaches and model output to identify dominant transformation/loss process.</li> <li>• Identify zones and time periods of potentially large transformations or removal</li> <li>• Quantify nutrient loads to the Delta, characterize and quantify nutrient transformations and losses during transit through the Delta, and quantify nutrient loads to Suisun Bay</li> <li>• Quantify the relative importance of major processes influencing nutrient concentrations, in space and</li> </ul>

# Delta RMP Year 1 Monitoring Design Summary – NUTRIENTS

		time <i>A currently funded SFEI-ASC project (due JUNE 2015) is addressing these objectives</i>
	SPLP 1.2.	What are the loads from tributaries to the Delta?
	SPLP 1.3.	What are the sources and loads of nutrients within the Delta?
	SPLP 1.4.	What role do internal sources play in influencing observed nutrient levels?
	SPLP 1.5.	Which factors in the Delta influence the effects of nutrients?
	SPLP 1.6.	What are the types and magnitudes of nutrient sinks within the Delta?
	SPLP 1.7.	What are the types and magnitudes of nutrient exports from the Delta to Suisun Bay and water intakes for the State and Federal Water Projects?

## Delta RMP Year 1 Monitoring Design Summary – NUTRIENTS

Proposed budget for 2014/15

<b>Task</b>	<b>Cost</b>	<b>Available</b>	<b>Shortfall</b>
<b>1. <i>Synthesis and analysis of existing information and data</i></b>			
1.1. Synthesis and analysis of historic data, including <ul style="list-style-type: none"> <li>a. Further improve understanding of spatial-temporal distribution of nutrients in the system</li> <li>b. Evaluation of high-frequency data</li> <li>c. Power analysis of existing data</li> <li>d. Identify critical data gaps</li> <li>e. Recommendations for methodology development</li> </ul>	\$150,000	\$30,000 <sup>7</sup>	\$120,000
<b>2. <i>Develop nutrient monitoring design</i></b>			
2.1 Develop subregion and habitat draft segmentations <ul style="list-style-type: none"> <li>a. Establish subregions</li> <li>b. Establish habitat definitions</li> </ul>	\$50,000	\$25,000 <sup>8</sup>	\$25,000
2.2 Develop specific monitoring/assessment plans to fill critical data gaps <ul style="list-style-type: none"> <li>a. Define sampling frame</li> <li>b. Identify data requirements</li> <li>c. Complete and vet nutrients element development approach/monitoring and design proposal</li> </ul>	\$115,000	\$35,000 <sup>9</sup>	\$80,000
<b>3. <i>Coordination</i></b>			
3.1. Coordination with the development of the Delta Nutrient Research Plan and related efforts	\$15,000	\$15,000 <sup>10</sup>	\$0
<b>Total amount</b>	<b>\$330,000</b>	<b>\$105,000</b>	<b>\$225,000</b>

<sup>7</sup> Synthesis of IEP-EMP discrete water quality data (SFEI-ASC; Funding source: DWR)

<sup>8</sup> Delta Nutrient Science Support (SFEI-ASC; Funding source: DSP)

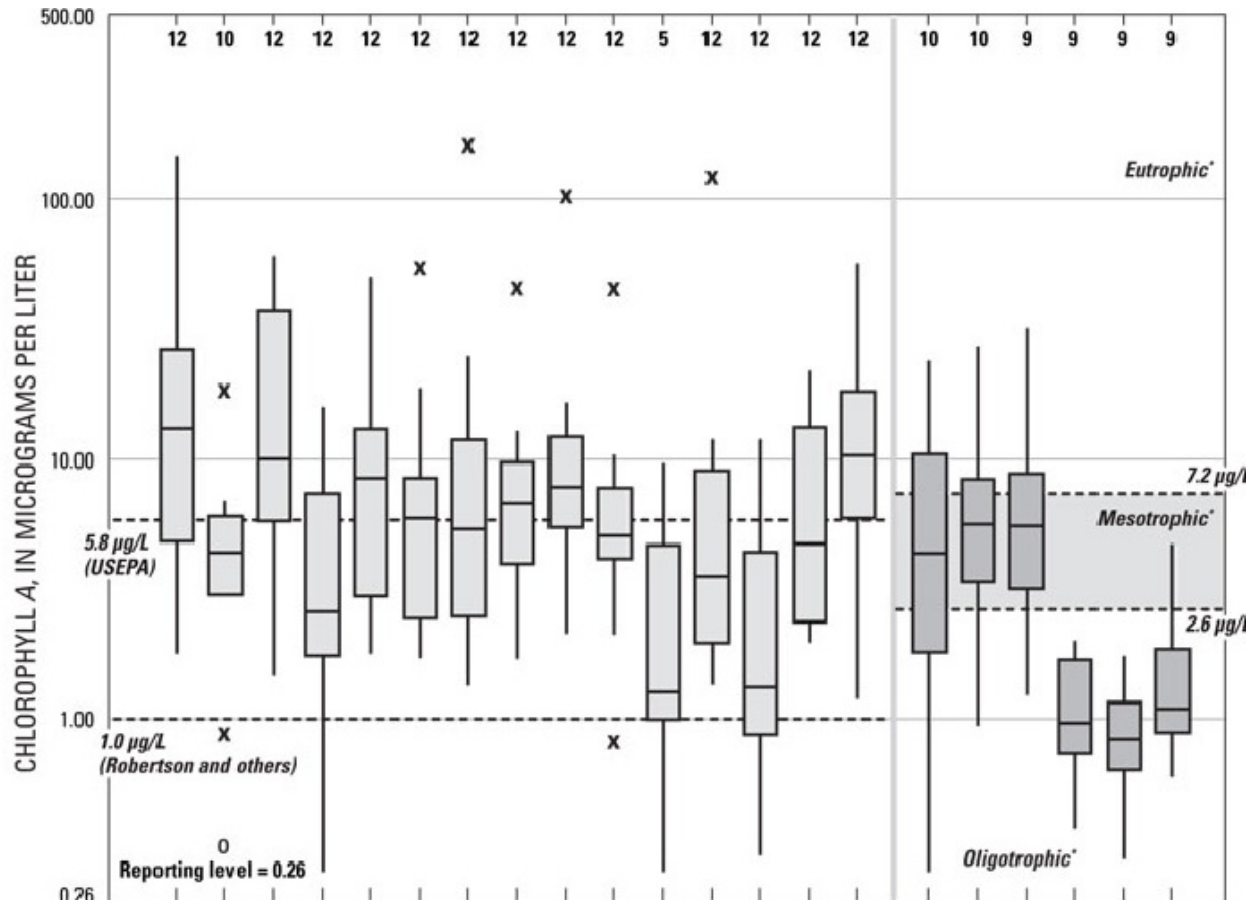
<sup>9</sup> Delta Nutrient Science Support (SFEI-ASC; Funding source: DSP): \$25,000; Delta RMP Implementation (SFEI-ASC; Funding Source: Central Valley Water Board): \$10,000

<sup>10</sup> Delta Nutrient Science Support (SFEI-ASC; Funding source: DSP); covers participation of SFEI-ASC in Delta Nutrient Research Plan Workgroups

## Examples for Data Analysis Products

### 1. Ranges in concentrations in Delta subareas in concentrations of nutrients and nutrient-associated parameters

EXAMPLE 1: Ranges in chl-a concentrations

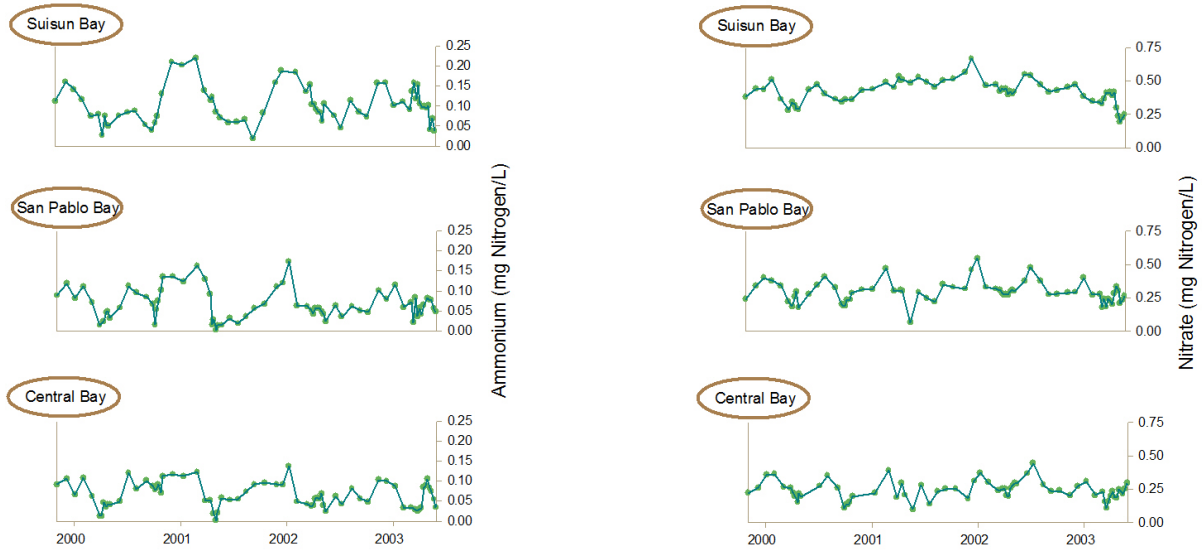


Representation: Box-and-whisker-plots; x axis can be station groups organized by subregion, habitat type, or subregion\*habitat type. Shown here: the distribution of total nitrogen concentrations, by site, in the Milwaukee Metropolitan Sewerage District planning area, Wis. From [Thomson et al., 2007](#)).

## 2. Temporal variability in concentrations of nutrients across subregions and habitat types

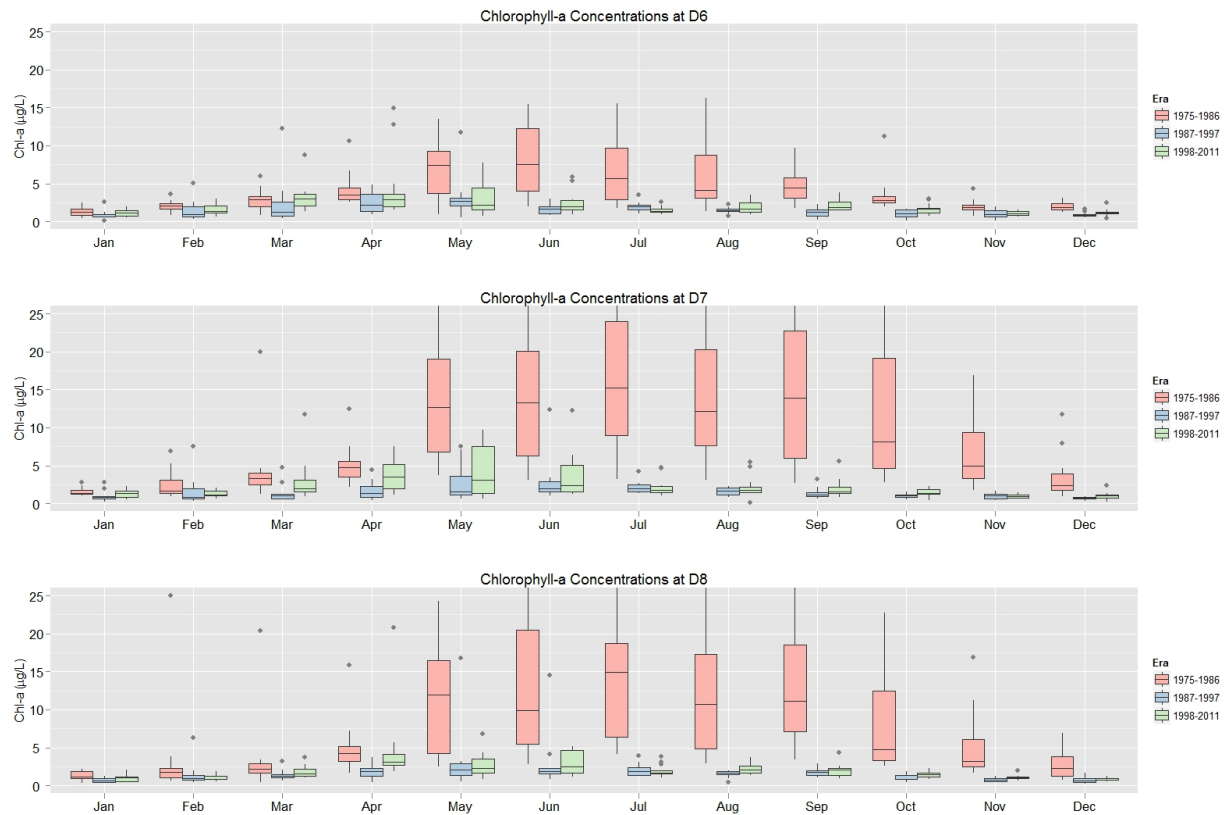
### EXAMPLE 2: Seasonal trends in ammonium and nitrate concentrations subregions

Shown here: monthly measurements of ammonium and nitrate in embayments (subregions) of the Northern San Francisco Estuary. From Pulse of the Delta 2011 (ASC), data adapted from Dugdale et al. (2007).



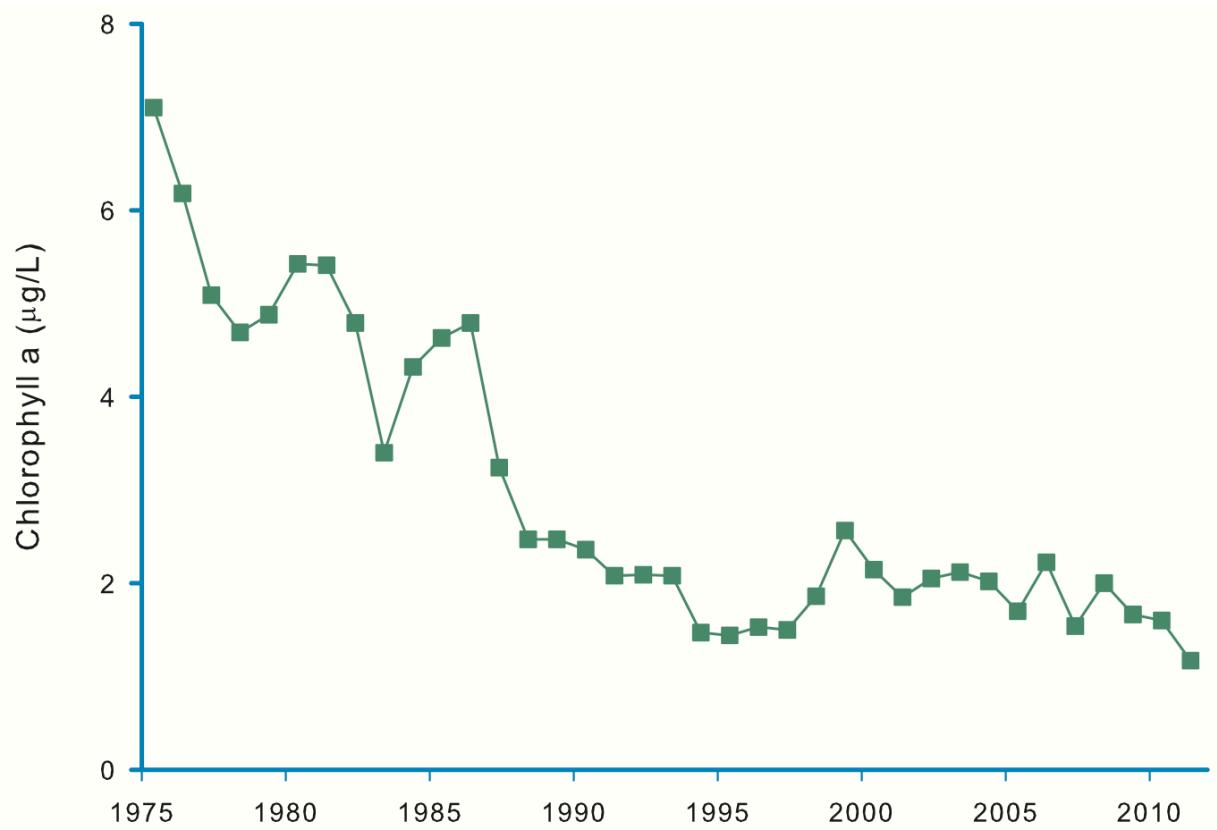
### 3. Seasonal, interannual, and decadal variability in concentrations of chl-a and DO across subregions and habitat types

EXAMPLE 3.1: Seasonal and decadal variations in chl-a concentrations

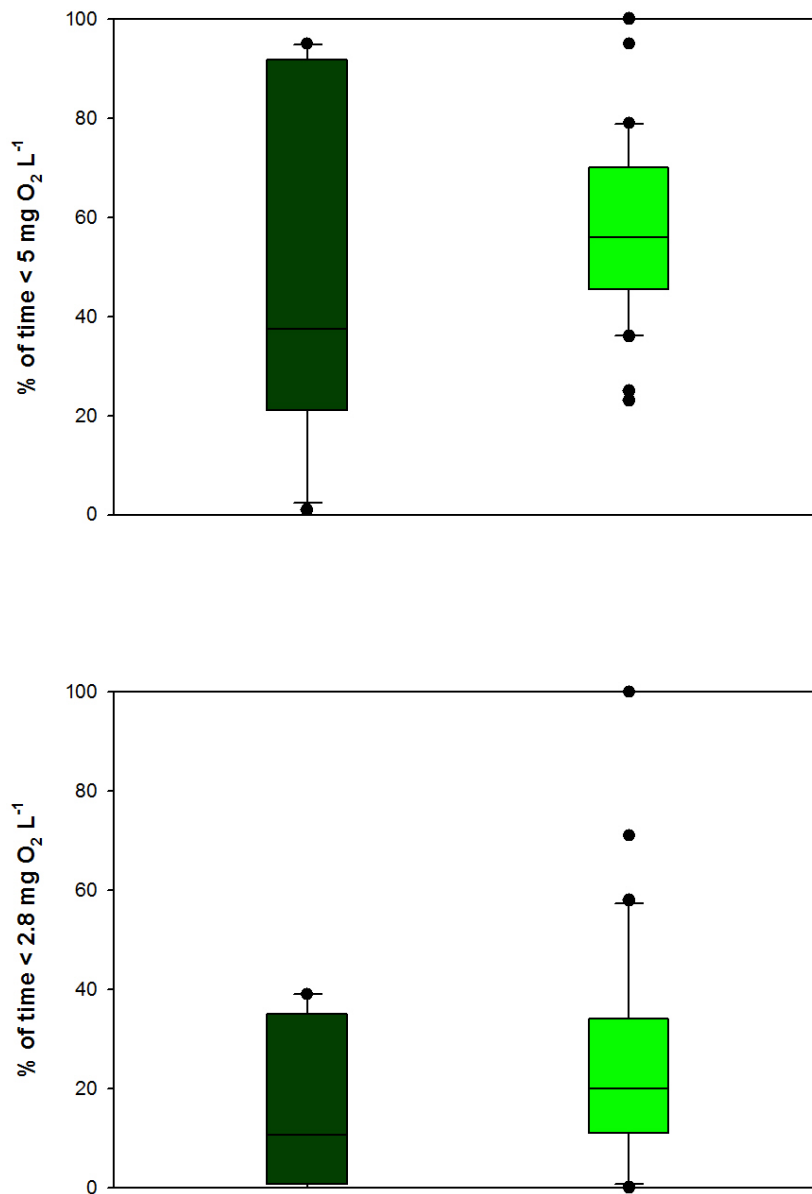


Representation: Box-and-whisker-plots; x-axis are months. Different colors represent different eras (1975-86, 1987-1997, 1998-2011). Shown here: monthly and decadal trends in chl-a concentrations at three Delta stations sampled by the IEP discrete water quality sampling program (DWR-EMP). (For the envisioned product, these plots would be made for subregions and habitat types instead of individual stations).

EXAMPLE 3.2: Interannual variation in chl-a concentrations



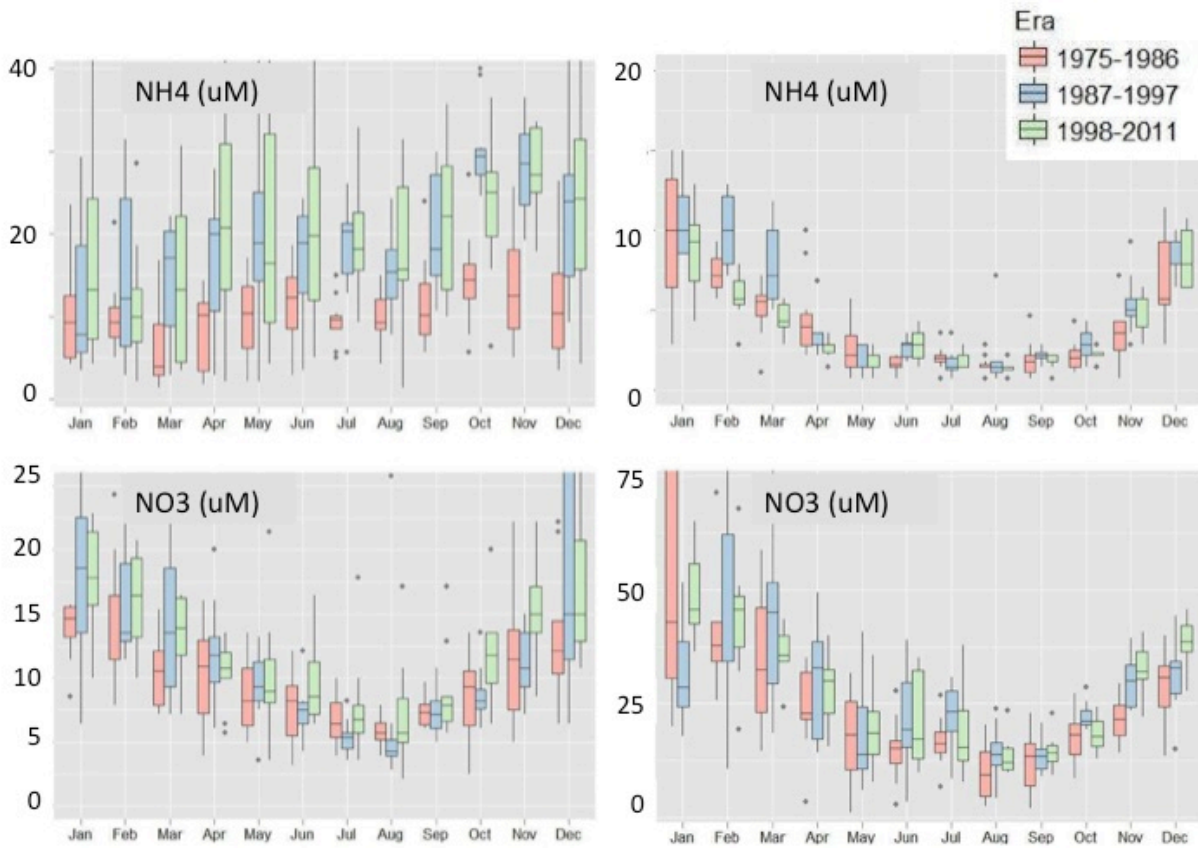
Shown here: Chl trends in Delta (annual Delta-wide averages), based on IEP discrete water quality data 1975-2011 (DWR-EMP).

*EXAMPLE 3.3: Ranges in DO concentrations*

Representation: Frequency of exceedance (%) vs. habitat type (box plots)[or subregion or subregion\*habitat type]. Shown here: Frequency of exceedance (%) vs. habitat type (box plots) in South San Francisco Bay. For calculating the mean (horizontal line inside each box), each station's frequency was considered as an individual value. Upper and lower edges of boxes are the upper and lower quartiles, and error bars represent  $\pm 1$  standard deviation. The value of 5 mg O<sub>2</sub> L<sup>-1</sup> is equivalent to the San Francisco Bay Basin Plan objectives for tidal waters downstream of the Carquinez Bridge (SFRWQCB 2013) and values below are generally considered to be oxidic but low quality waters (Vaquer-Sunyer and Duarte 2008, Sutula et al. 2012). Waters with DO concentrations < 2.8 mg O<sub>2</sub> L<sup>-1</sup> are considered hypoxic and acutely toxic to fish (Sutula et al. 2012). The examples are from a synthesis of existing DO data in South SF Bay (Jabusch et al. 2013).

#### **4. Spatial, seasonal, and temporal trends in nutrient concentrations and proportions**

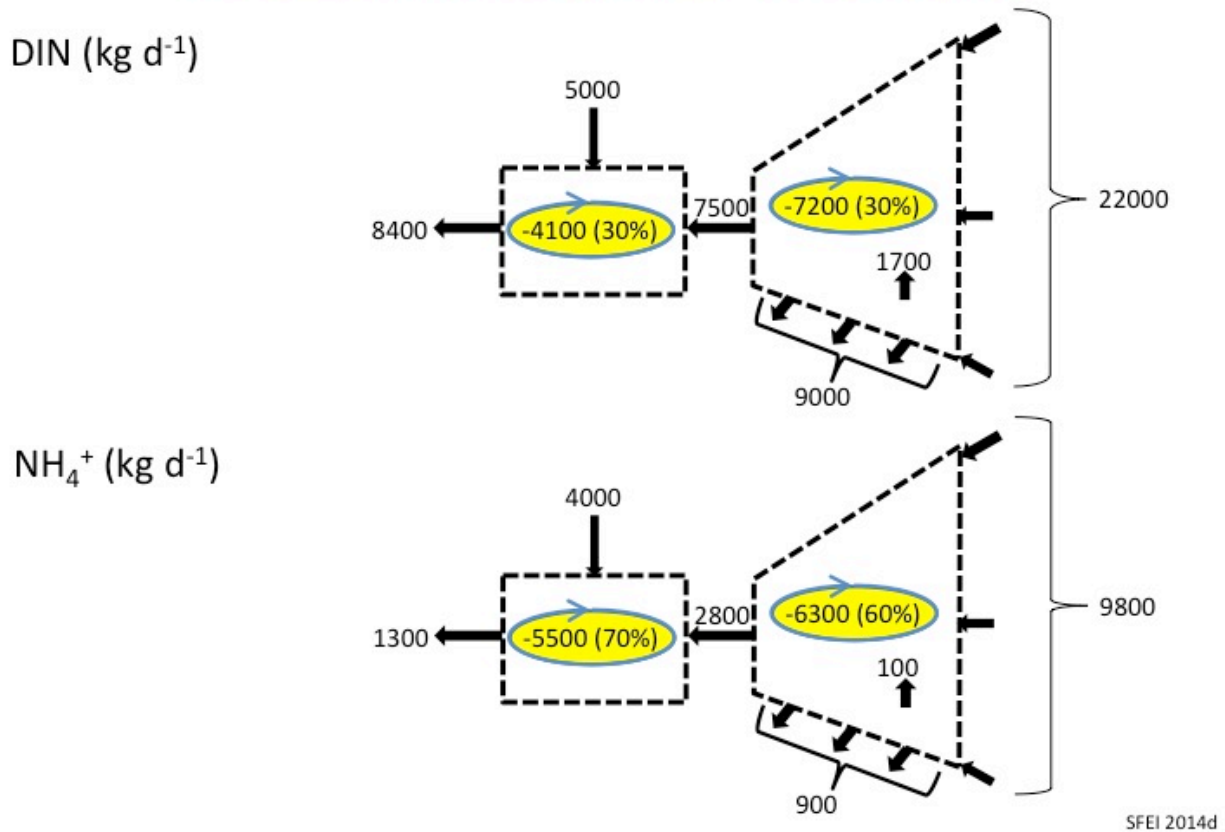
EXAMPLE 4: Seasonal and decadal variations in  $\text{NH}_4$  and  $\text{NO}_3$  concentrations



Representation: Box-and-whisker-plots; x-axis are months. Different colors represent different eras (1975-86, 1987-1997, 1998-2011). Shown here: monthly and decadal trends in ammonium and nitrate concentrations at two Delta stations sampled by the IEP discrete water quality sampling program (DWR-EMP). (For the envisioned product, these plots would be made for subregions and habitat types instead of individual stations).

5. Delta-wide mass balance of  $NH_4$ ,  $NO_3$ , DIN, TDN, and  $PO_4$

EXAMPLE 5: Mass balance for Delta and Suisun-Bay (June – October)

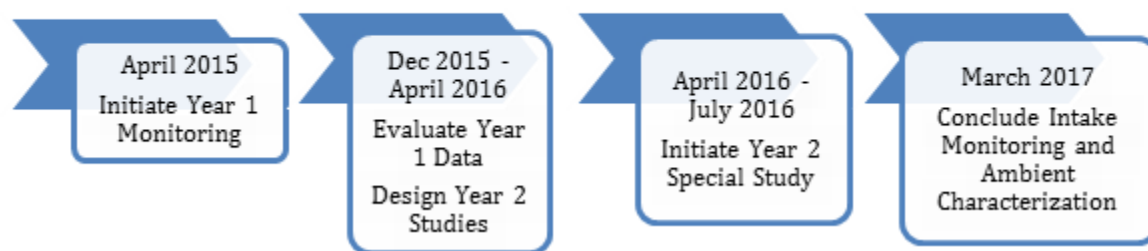


Shown here: a rough steady-state mass balance for dissolved inorganic nitrogen (DIN) and ammonium (NH<sub>4</sub><sup>+</sup>) for Delta and Suisun-Bay (June – October)(kg/d). Proposed data analyses would further our understanding of nutrient loads to the Delta and Suisun Bay; nutrient transformations and losses during transit through the Delta; and zones and time periods of potentially large transformations or removal. It would also help evaluate dominant transformation and loss process and the relative importance of major processes influencing nutrient concentrations in space and time.

## Monitoring Design Summary – Pathogen Study

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) adopted a Basin Plan Amendment to establish a Drinking Water Policy (Policy) to protect source water quality on July 26, 2013. The Policy includes a narrative water quality objective for two pathogens, *Cryptosporidium* and *Giardia*, with associated implementation and monitoring provisions, as well as language addressing other constituents of potential concern to drinking water. The proposed Pathogen Study is intended to satisfy the data needs and monitoring for any follow-up required if Basin Plan trigger values are exceeded.

The Pathogen Study will be performed over two or more years. The first two years include ambient characterization monitoring coordinated through the Delta RMP, concurrent with water intake monitoring performed by drinking water agencies. Based on an assessment of data collected in the first year of the characterization study, a Delta subarea could be targeted for special studies of infectability, source tracking, hydrodynamics, and decay and growth. The roles and responsibilities for planning, administering, and conducting the Pathogen Study are shown in **Appendix 1**. It is expected that the Central Valley Drinking Water Policy Workgroup<sup>11</sup> (CVDWPWG) would administer the Pathogen Study, and lead study design, monitoring and data coordination, and data assessments. The timeline for the Pathogen Study is shown below.



### 1.1. YEAR 1 MONITORING

Year one of the Pathogen Study will focus on characterizing pathogen (*Cryptosporidium* and *Giardia*) levels to address the objectives of the Pathogen Special Study required by the Central Valley Drinking Water Policy Basin Plan Amendment. The study includes monitoring at the drinking water intake locations and at ambient locations throughout the Delta.

#### 1.1.1. Water Intake Sampling

As part of the second round of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2), water supply agencies are required to collect *Cryptosporidium* and *Giardia* samples monthly for two years in the source waters at treatment plant intakes<sup>12</sup> starting in April 2015. These data will be used to

<sup>11</sup> The CVDWPWG is made up of representatives from many of the agencies participating in the Delta RMP including the Regional Water Board, Water Supply, POTWs, Stormwater and Agricultural representatives.

<sup>12</sup> LT2 Source Water Monitoring Guidance specifies that “LT2 Rule monitoring is intended to assess the mean *Cryptosporidium* level in the influent to drinking water plants that treat surface water or ground water under the direct influence (GWUDI) of surface water. PWSs are required to collect source water samples for the LT2 Rule from each plant intake prior to chemical treatment”

determine if the bin levels<sup>13</sup> assigned after the first round of monitoring are still valid or need to be revised. The second round of monitoring will also be used to evaluate conditions relative to the Basin Plan trigger levels (80% of bin level). For this intake monitoring, there is no direct sampling cost to the Delta RMP, and therefore no range of activity and costs. Indirect costs to the Delta RMP could be incurred to work with the CVDWPWG to coordinate, compile, and review the first year of data for the assessment. A summary of the effort is provided in **Table 1**.

Water intake sampling will address the following questions:

ST1 Are current pathogen levels supportive of the municipal drinking water quality beneficial use as described in the Basin Plan?

A. Are the current pathogen levels for each Delta water intake and those immediately upstream (i.e., Sacramento Area) different than the previous LT2 sampling? Are any drinking water intakes reclassified into a higher bin level?

B. Are Basin Plan trigger values exceeded?

#### **1.1.1.1. Water Intake Monitoring Sites**

Water agencies are required to sample their source waters at the intakes to treatment facilities for LT2 monitoring, which in some cases include a blend of multiple “raw” water sources. All data would be considered for the purpose of evaluating the bin levels; however, the blended sources may require additional investigation. The LT2 intake data can be used for the bin change assessment. **Figure 1** shows the locations of the LT2 intake sampling along with the ambient locations.

**Table 1.** Long Term 2 Enhanced Surface Water Treatment Rule water intake sample collection.

<b>Design</b>	<b><i>7 drinking water intake sites, each with a single source, and 2 facilities with blending from 4 drinking water intakes.</i></b>
Frequency	Monthly
Schedule	April 2015-March 2017
Co-location	All LT2 sampling sites, constituent list TBD
Coordination	Water agencies will collect and analyze samples; CVDWPWG and Delta RMP will coordinate, compile, and review the first year of data for the assessment
Unit Cost	\$0 per site for sample collection and analysis
Annual Cost	Coordination with water agencies provided as in-kind service; cost is not estimated. See Table 3 for Year 1 cost estimate

[http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/guide\\_lt2\\_swmonitoringguidance.pdf](http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/guide_lt2_swmonitoringguidance.pdf)

<sup>13</sup> [http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/fs\\_sw\\_monitoring\\_fs\\_sch\\_1-3\\_final.pdf](http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/fs_sw_monitoring_fs_sch_1-3_final.pdf)

### 1.1.2. Ambient Sampling

Ambient sampling will be performed by the Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI) Program. The ambient monitoring design is summarized in **Table 2**. Potential analytical laboratories certified for EPA Method 1623 for *Cryptosporidium* and *Giardia* are shown in **Table 3**. The primary laboratory will perform most all analysis and the secondary laboratory will analyze inter-laboratory quality control samples.

Ambient sampling results, when analyzed in coordination with the intake sampling results, will address the following questions:

SPLP1 Can any changes in bin level be attributed to an identifiable event, condition, or changes in a source?

- A. What are the concentrations in ambient waters upstream or downstream from intakes with observed changes to bin levels?
- B. What is the influence of sources (agriculture, POTWs, urban runoff, upstream tributary, natural, recreation, and other) on pathogen levels at drinking water intakes?
- C. Are there new discharges or changes in sources or conditions that could explain the change in bin level compared to previous LT2 monitoring?

#### 1.1.2.1 Ambient Monitoring Sites

Ambient sites are co-located with existing MWQI sites as shown in **Table 4**. Some sites are upstream of the Delta, but could influence water quality at the drinking water intakes or are representative of larger areas with the same land uses. **Figure 1** shows the LT2 intake sampling sites and the ambient sampling sites. The mid-range sample collection frequency shown in **Table 2** is the preferred approach as it matches the frequency of the expected LT2 water intake sample collection, and there is no significant benefit to an increased sample collection frequency.

# Delta RMP Year 1 Monitoring Design Summary – PATHOGEN STUDY

**Table 2.** Ambient sample collection.

<b>Funding Level</b>	<b>Lower</b>	<b>Mid-range</b>	<b>Higher</b>
<b>Design</b>		12 fixed ambient Delta sites co-located with MWQI locations	
<b>Frequency</b>	Every other month	Monthly	Twice Monthly
<b>Co-location</b>	.	MWQI program constituent list (varies by program, but typically includes Std. mineral and nutrients, TOC, DOC, UVA, suspended solids and/or turbidity)	
<b>Coordination</b>		Assumes sampling provided in-kind by MWQI, in-kind services included in cost estimates	
<b>Unit Sample Cost:</b>		\$500 per sample, adjusted for QC samples	
<b>Annual Cost</b>		Coordination with MWQI provided as in-kind service. See Table 8 for Year 1 cost estimate.	

**Table 3.** Analytical laboratories.

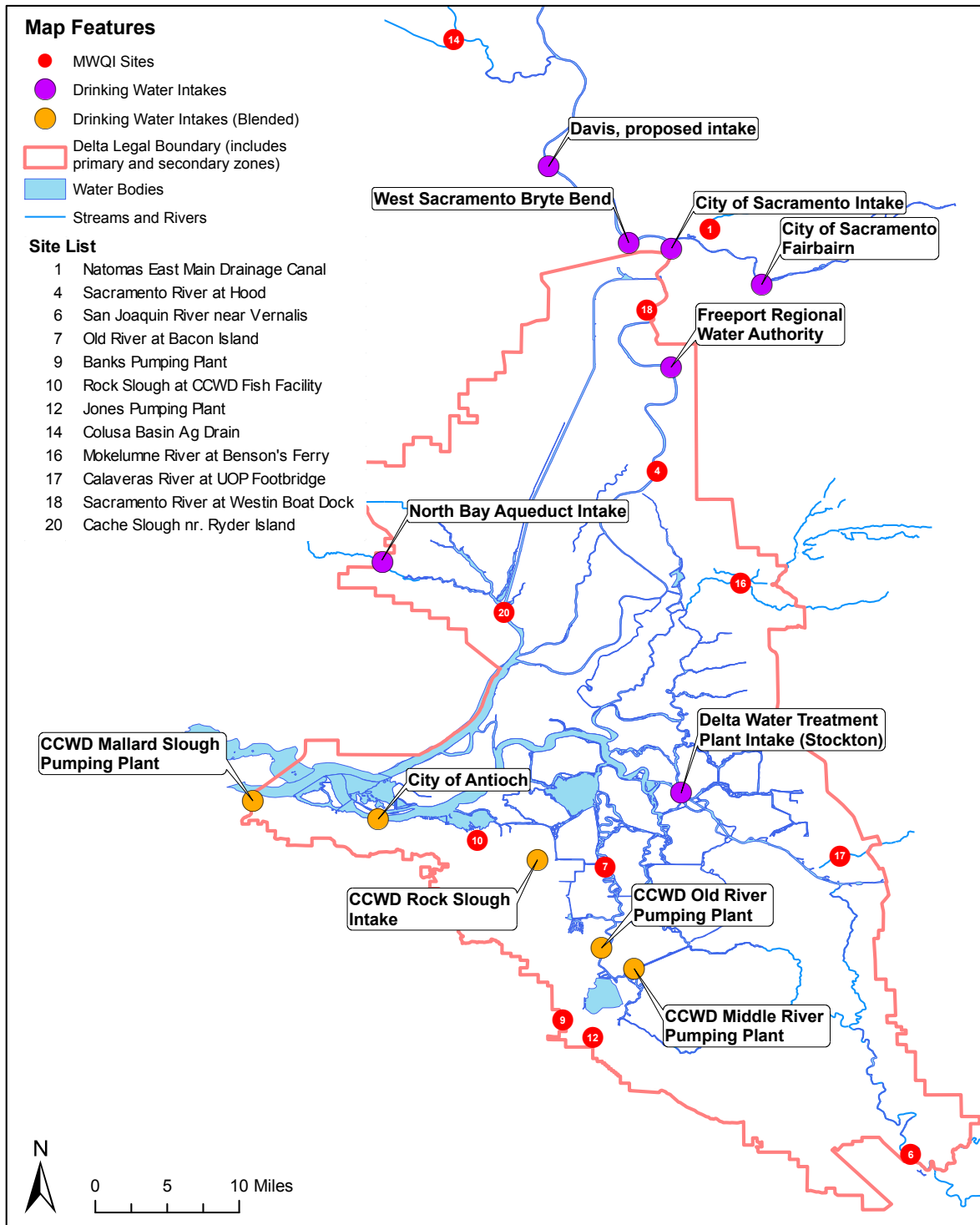
<b>Analytical Lab</b>	<b>Address</b>	<b>Contact</b>	<b>Service</b>
Biovir	685 Stone Road Benicia, CA 94510	Ramon Aboytes aboytesr@iehinc.com 707 747 5906	EPA Method 1623 for <i>Cryptosporidium</i> and <i>Giardia</i>  <i>Cryptosporidium</i> sporozoites infectivity assay (Cell Cultures-IFA-Based Foci Detection)
Eurofins	110 South Hill Street South Bend, IN 46617	Rick Zimmer RickZimmer@eurofinsUS.com 949 540 6723 Mobile: 949 466 8266	EPA Method 1623 for <i>Cryptosporidium</i> and <i>Giardia</i>

**Table 4.** Ambient monitoring locations.

<b>Location ID</b>	<b>Description</b>	<b>Source(s) Represented</b>	<b>Rationale for Inclusion</b>
MWQI #14	Colusa Basin Ag Drain	Agriculture	Source representation
MWQI #1	Natomas East Main Drainage Canal	Stormwater, Agriculture	Source representation
MWQI #18	Sacramento River at Westin Boat Dock	Stormwater, Combined Sewer System	Proximity to intakes
MWQI #4	Sacramento River at Hood	Stormwater, Wastewater	General characterization
MWQI #20	Cache Slough near Ryder Island	Wetlands	Source Representation
MWQI #16	Mokelumne River at Benson's Ferry		Input to Delta
MWQI #17	Calaveras River at UOP Footbridge	Stormwater	Source representation
MWQI #10	Rock Slough at CCWD Fish Facility		General characterization
MWQI #7	Old River at Bacon Island		General characterization
MWQI #9	Banks Pumping Plant		Export from Delta
MWQI #12	Jones Pumping Plant		Export from Delta
MWQI #6	San Joaquin River near Vernalis		Input to Delta

**Figure 1.** Water intake, raw source, and ambient (MWQI) sampling sites.

## Drinking Water Intakes and MWQI Monitoring Locations in the Delta



**1.1.3. Data Products**

The data products for Year 1 of the characterization study will include a summary table to identify bin changes for each intake compared to the 2007 assessment, including a rolling average maximum and bin level assignment (**Table 5**). In addition, the ambient data will be summarized to characterize conditions near intake locations where changes in bin levels were observed. The data product to summarize ambient conditions will include tabulated (**Table 6**) and mapped (**Figure 2**) summaries of ambient concentrations in the vicinity of observed bin level changes. Additional scatter plots and distributional or trend plots will be prepared to compare sites or events as shown in **Figure 3**.

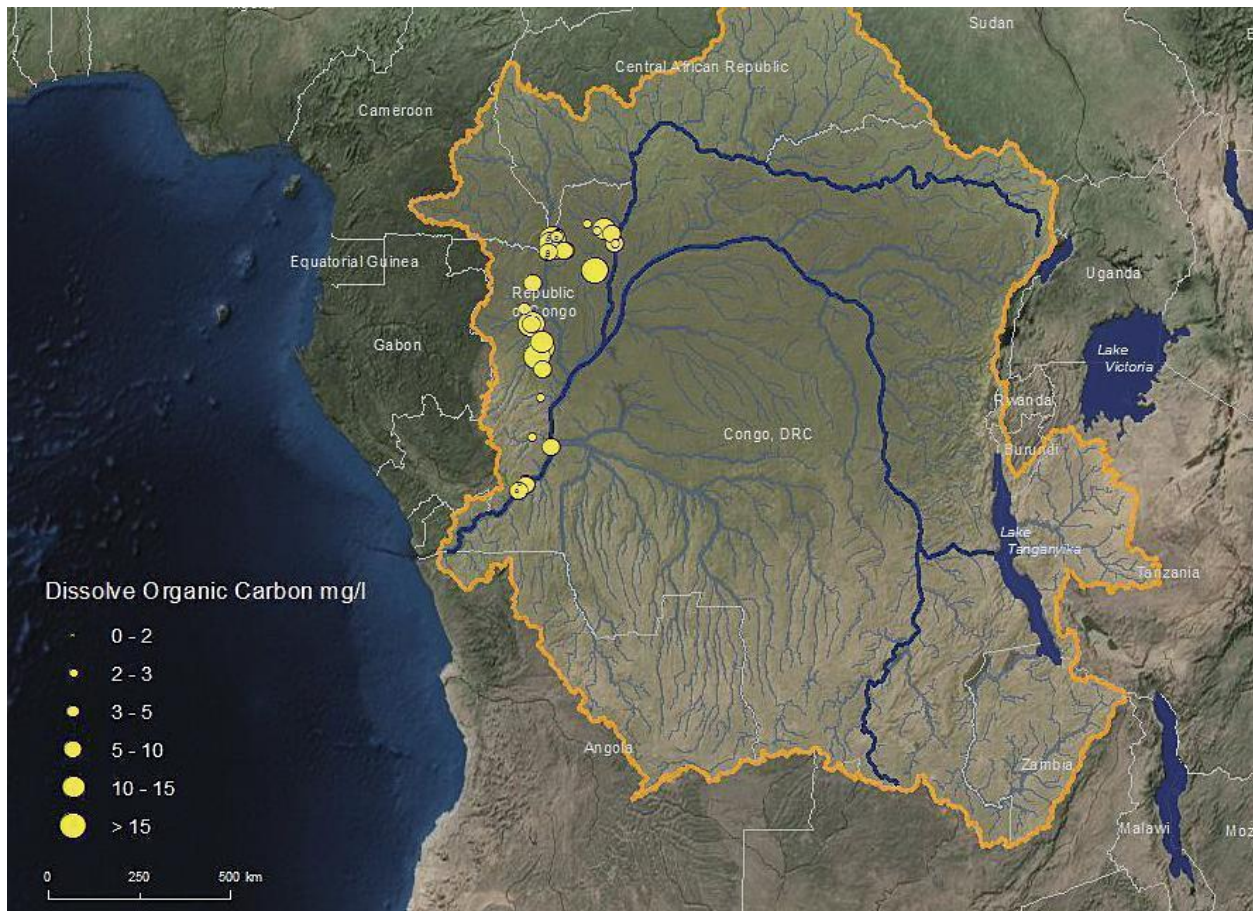
**Table 5.** Historic and current estimated bin levels and trigger assessments for Delta drinking water agencies.

<b>Water Agency Facility</b>	<b>2007 Bin Level</b>	<b>2015-17 Maximum Annual Running Average</b>	<b>Percent Detected Cryptosporidium</b>	<b>Estimated 2015-17 Bin Level</b>	<b>Trigger Exceedance Assessment</b>
Intakes with Single Source Water					
Davis/Woodland/UC Davis	NA				
West Sacramento	1				
City of Sacramento (Sacramento River)	1				
City of Sacramento (Fairbairn)	1				
Freeport Regional Water Authority	1				
North Bay Aqueduct Intake	1				
Delta Water Treatment Plant Intake (Stockton)	1				
Intakes with Blended Source Water					
City of Antioch	1				
Contra Costa Water District	1				

**Table 6.** Ambient concentrations of *Cryptosporidium* at ambient sites near intake locations with bin changes.

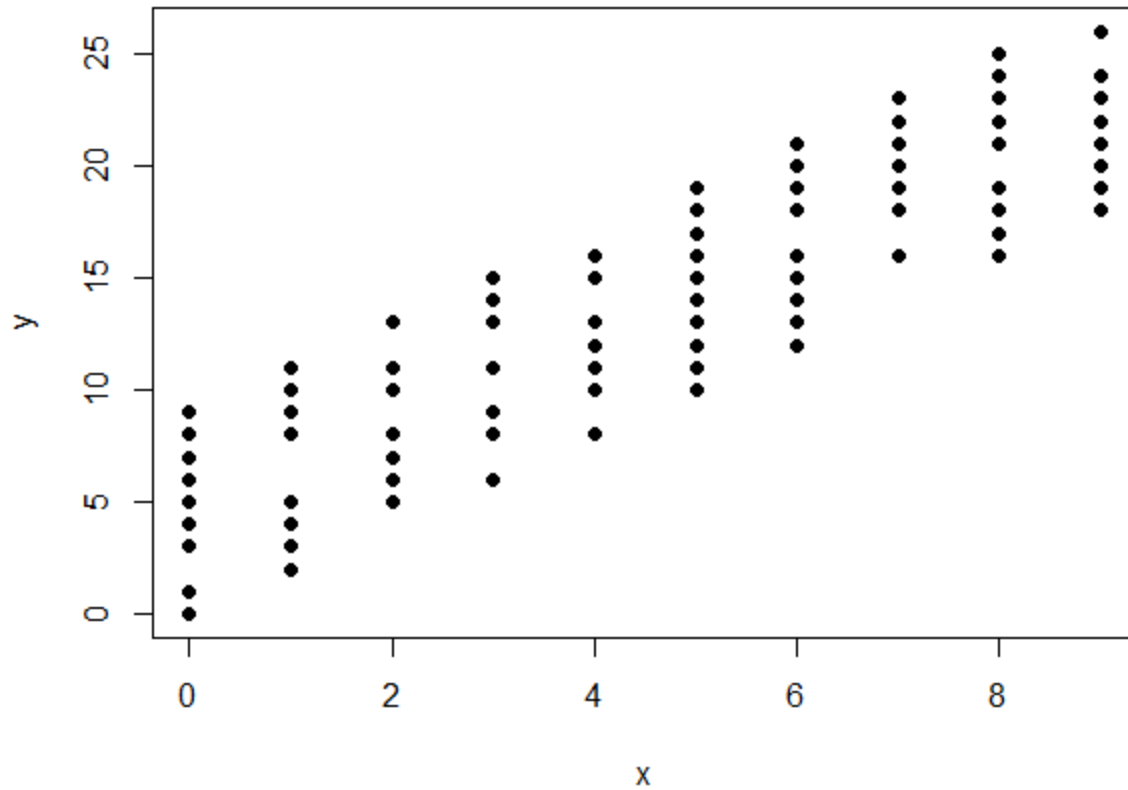
<b>Ambient Monitoring Site</b>	<b>Average Concentration</b>	<b>Maximum Concentration</b>	<b>Minimum Concentration</b>	<b>Percent Detected</b>
MWQI #14				
MWQI #1				
MWQI #18				
MWQI #4				
MWQI #20				
MWQI #16				
MWQI #17				
MWQI #10				
MWQI #7				
MWQI #9				
MWQI #12				
MWQI #6				

**\*\*Map with data summary to indicate ambient concentrations and percent detection (dot size, etc.)\*\***



**Figure 2.** Example map for concentrations and percent detection of *Cryptosporidium*.

\*\*Scatter plot with visualization of all data to display distribution by site, additional plots to show distribution by month; also for *Giardia*\*\*



**Figure 3.** Example plot for observed *Cryptosporidium* at drinking water intakes and ambient locations.

## 1.2. YEAR 2 SPECIAL STUDY MONITORING

During the second year of the Pathogen Study, the same level-of-effort will continue for water intake and ambient characterization, with the addition of special studies. The special studies will be selected based on an analysis of the data collected during Year 1, as described in the following section. During the end of Year 1, the Delta RMP will design Year 2 monitoring to address the additional assessment questions, depending on the available funds, and additional time may be necessary to completely address the assessment questions. The Year 2 special studies would further evaluate the following assessment questions:

SPLP1 Can any changes in bin level be attributed to an identifiable event, condition, or changes in a source? [also informed by water intake and ambient characterization monitoring]

- A. What are the concentrations in ambient waters in areas adjacent to intakes with observed changes to bin levels?
- B. What is the influence of sources (agriculture, POTWs, urban runoff, upstream tributary, natural, recreation, and other) on pathogen levels at drinking water intakes?
- C. Are there new discharges or changes in sources or conditions that could explain the change in bin level?

SPLP2 What is the viability and infectivity of pathogens at drinking water intakes?

- A. What percentage of *Cryptosporidium* found in ambient waters and source waters can cause infection?

SPLP3 What are the factors affecting decay and growth rates and can they be quantified and characterized for the purpose of modeling?

- A. Is there recent research or literature on the environmental fate of *Cryptosporidium* and *Giardia* that can be used to develop decay/growth rates in models?
- B. What are the observed changes in *Cryptosporidium* and *Giardia* concentrations as a pulse of ambient water or source water moves through the watershed and Delta?

### 1.2.1 Data Assessment to Determine Year 2 Special Study Monitoring

After 8-12 months of data are available from the Year 1 study, the drinking water intake data will be evaluated to determine likely trigger exceedances at drinking water intakes. The Drinking Water Policy Basin Plan amendment defines the trigger as the *Cryptosporidium* concentration reaching 80% of the next highest bin level. This assessment process will also evaluate the ambient concentrations of *Cryptosporidium* near to the intakes where any bin changes were identified. If no bin changes are observed or expected, a Year 2 special study would be performed in the Sacramento area because this area has the highest density of water intakes, in the previous LT2 sampling one intake in the area was close to the Basin Plan trigger, and the influences from different sources can be better discerned.

### 1.2.2 Year 2 Special Study Design

The Year 2 study will be designed following the process shown in **Figure 4**. Year 2 monitoring may include the following tools and studies to address the Year 2 assessment questions:

**Infectivity monitoring** – *Cryptosporidium* infectivity can be assessed by a cell culture method known as the *Cryptosporidium* sporozoites infectivity assay (Cell Cultures-IFA-Based Foci Detection). However,

there is not an analogous method currently available for *Giardia*, as host infection methods can be expensive and rely on infecting mammals.

Infectivity monitoring is dependent on sufficient detection of *Cryptosporidium*. If a site is identified with consistent detection of *Cryptosporidium*, an infectivity assessment could potentially provide information about whether *Cryptosporidium* oocysts are capable of causing an infection in humans. If there are no ambient sites with sufficient detection, infectivity monitoring could be conducted at source locations (e.g., wastewater treatment plant effluent).

Infectivity monitoring could be used to evaluate whether there are infectivity rate differences between *Cryptosporidium* in ambient waters and sources, provided that there is sufficient detection in ambient waters.

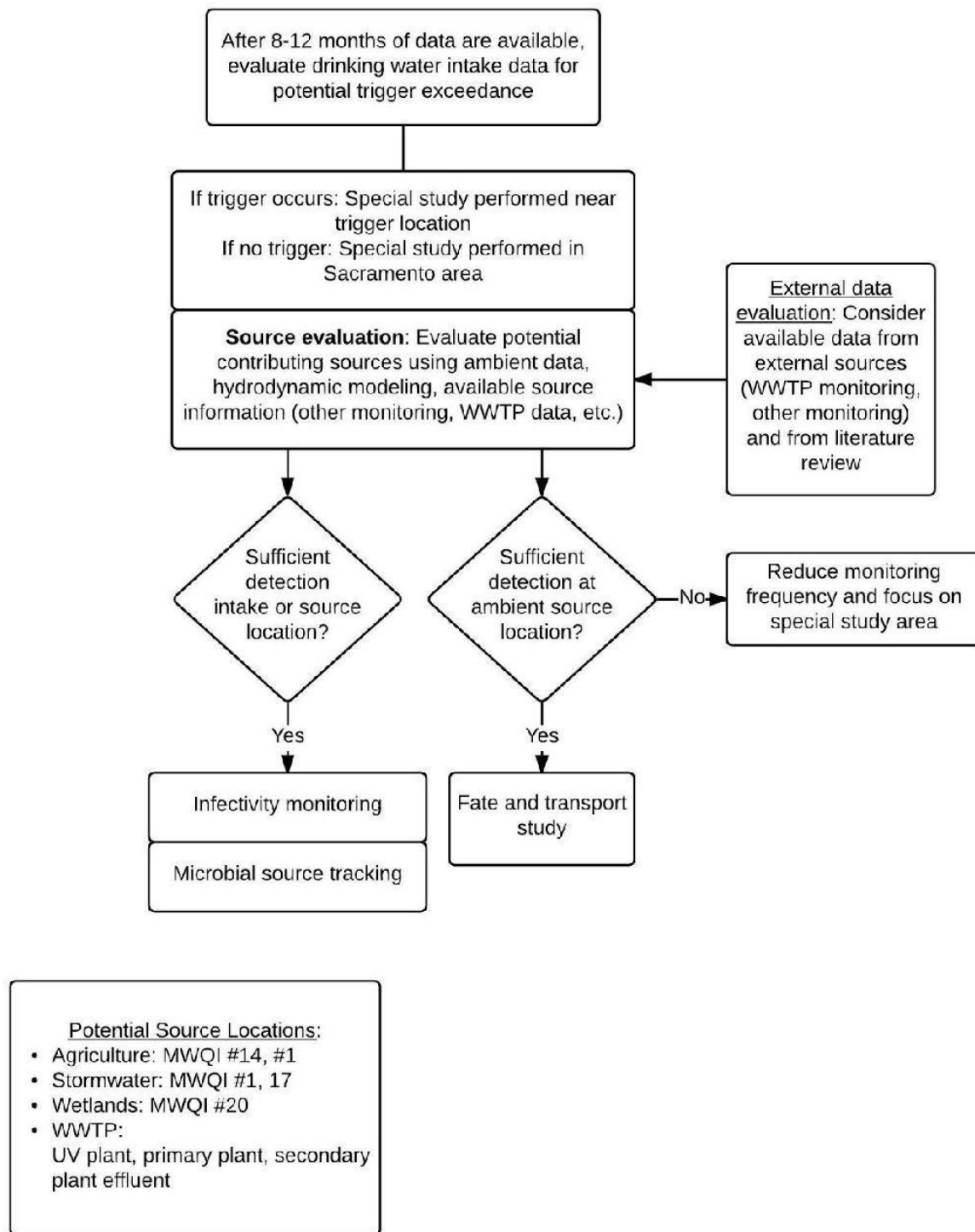
**Microbial source tracking (MST)** - MST utilizing polymerase chain reaction (PCR) techniques examines specific nucleic acid sequences from intestinal bacteria (*Bacteroidales*) that can provide detail on the origin of the microbes and associated pathogenic organisms. This technique can provide additional information to evaluate the influence of sources at drinking water intakes.

These analyses would be performed as follow-up to a likely trigger exceedance. Analyzing ambient samples in the vicinity of intakes with a likely trigger exceedance can provide information on the relative host contributions (e.g., gull, cow/horse, dog, human sources) to bacteria populations at the ambient locations of interest. That information could help in deciding what sources should be investigated as potential contributors (e.g., agriculture if bacteria from cow/horse are a high percentage of total bacteria).

**Hydrodynamics** – The relative contribution of upstream sources (tributaries) to a water intake would be examined using available fingerprinting outputs from observed and modeled conditions. This evaluation may be performed in Year 1 if likely bin level changes are observed. Fingerprinting would be developed on monthly basis by DWR, and source volumetric contributions would be developed through existing data (DWR, USGS, and other gages) and estimates developed by others (stormwater, agriculture, other). A summary would be developed of the monthly fingerprinting and estimates of the relative volumetric comparison from sources to the location of the bin level change. This information would help determine if an upstream source, given its volumetric contribution, could potentially have contributed a sufficient concentration of pathogens to be a factor in a bin level change.

**Fate and transport** – The fate and transport of protozoan pathogens in the Delta could be examined through a literature evaluation, and potentially through an in-situ evaluation. A literature review and summary would first be necessary, and could be performed during Year 1. Information on decay rates and environmental processes could be used to inform modeling efforts.

If *Cryptosporidium* and *Giardia* are detected at high concentrations in ambient locations, an in-situ study could be performed to follow a pulse of ambient water through the watershed to observe changes in *Cryptosporidium* and *Giardia* concentrations. This study would be costly, and would rely on consistent detection of the protozoa in the ambient water.



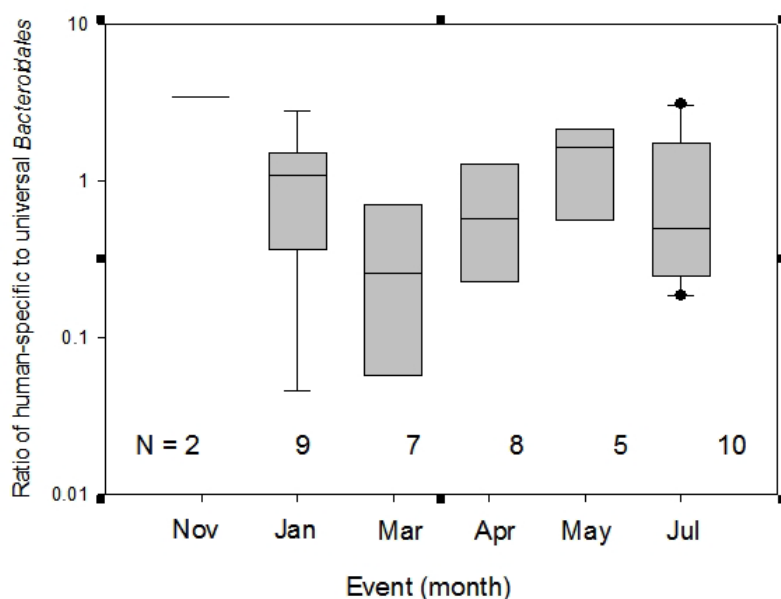
**Figure 4.** Year 1 assessment process to identify and locate Year 2 additional study.

### 1.2.3. Year 2 Special Study Data Products

The data products for the Special Studies conducted during Year 2 of the Pathogen Study will include a tabular summary of infectivity rates (oocysts/infection) for ambient waters and source waters for infectivity assessments (**Table 7**). Microbial source tracking data will be summarized in tables or graphs of the relative percent contribution by host of the total *Bacteroidales* at each site and time point (**Figure 5**). Summaries would be developed of the monthly hydrodynamic fingerprinting, with estimates of the relative volumetric comparison from sources to the location of the bin level change (**Figure 6**).

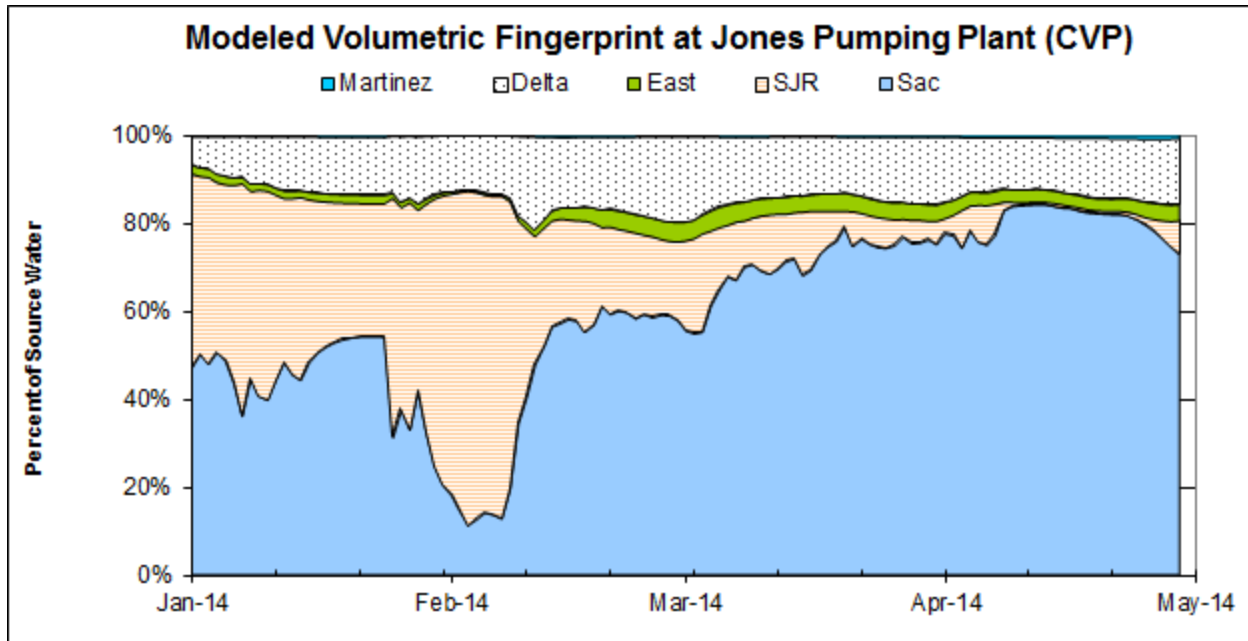
**Table 7.** Concentrations of *Cryptosporidium* and percent infectious *Cryptosporidium* at ambient sites and in source waters.

Location	n	% Positive for <i>Cryptosporidium</i>		Minimum <i>Cryptosporidium</i> Concentration		Maximum <i>Cryptosporidium</i> Concentration		Mean <i>Cryptosporidium</i> Concentration		Mean % Infectious
		Total	Infectious	Total	Infectious	Total	Infectious	Total	Infectious	
TBD Based on detection in Year 1	6									



**Figure 5.** Example<sup>14</sup> of figure showing relative percent contribution of human-specific *Bacteroidales*

<sup>14</sup> from Sirikanchana, K., Bombardelli, F., Wang, D., Wuertz, S. 2008. Monitoring and Modeling Non-Point Source Contributions of Host-Specific Fecal Contamination in San Pablo Bay. UC Water Resources Center Technical Completion Report Project No. WR1015.



**Figure 6.** Example of figure showing volumetric fingerprint at an intake location.

#### 1.2.4 Future Study Assessments

The following forecasting and modeling (FM) assessment questions were not specifically described in the Basin Plan Amendment, but are included in the Delta RMP as additional potential needs to consider management options. These higher-level assessments would require higher resolution models and significant effort, and are not expected to be performed in Years 1 or 2.

**FM1** What is the effect of source controls on pathogen levels at drinking water intakes?

- A. Can source controls effectively and feasibly change pathogen concentrations at the water intakes?

**FM2** How will proposed restoration projects, water operations, and future urban growth affect municipal drinking water intake bin levels?

- A. What land use and discharge changes could cause changes in bin levels?
- B. What is the direction and magnitude of expected changes in pathogen concentrations at the water intakes?

### **1.3. COST ESTIMATE**

Total costs for the Pathogen Study can be summarized based on the contributing source of funds since much of the study would be performed with in-kind contributions. The Delta RMP would provide the administrative means to account for the in-kind contributions from the Central Valley Drinking Water Policy Workgroup (administration, coordination, oversight, and reporting) and MWQI (sample collection) and analytical costs would be funded by the Delta RMP. It is expected that the Delta RMP would also provide tools such as database formats, reporting formats, as-needed technical expertise, and report preparation assistance.

#### **1.3.1. Year 1 Cost Estimate**

A cost estimate was developed to evaluate a range of study options as summarized in **Table 2**. The preferred and recommended approach is the “mid-range” alternative, which matches the LT2 frequency of monthly sample collection. The water intake sample collection will be performed by other agencies and will not incur any cost to the Delta RMP. The ambient sample collection will be performed by MWQI with the Delta RMP only paying the cost of sample delivery and analysis. However, the incremental sample collection cost (i.e., increased cost over their existing planned sample collection) is also provided in **Table 8**, though this would not be a direct cost to the Delta RMP, but rather an in-kind contribution from the State Water Project Contractors Authority, which funds the MWQI Program. There are also program administration, coordination, and reporting costs that are not included at this time because they will be part of overall management costs to the Delta RMP and while some costs may be specific to the Pathogen study, they should not be substantially different than other studies. Moreover, it is expected that much of this coordination support will come through in-kind contribution from the Central Valley Drinking Water Policy Group and Delta RMP stakeholders. It may be necessary to estimate these costs to quantify in-kind or Delta RMP costs, but it should be done in the context of the overall Delta RMP management.

**Table 8.** Estimated costs for first year of monitoring (April 2015 – March 2016).

	<b>Lower</b> Every other month at 12 sites	<b>Mid- range</b> Monthly at 12 sites	<b>Higher</b> Twice monthly at 12 sites	
<b>RMP Administration</b>				<b>Notes</b>
Project Initiation and Planning	TBD	TBD	TBD	In-kind by CVDWPWG; finalize Work Plan, QAPP
Pre-event Preparations	TBD	TBD	TBD	Performed by MWQI as in-kind contribution; coordination
Post-event Wrap-up	TBD	TBD	TBD	In-kind by CVDWPWG; laboratory follow-up review summaries
<b>Total</b>	TBD	TBD	TBD	
<b>Water Intakes Sample Analysis</b>				
Environmental Samples	\$0	\$0	\$0	
<b>Ambient Sample Analysis</b>				
Environmental Samples + 25% QC	\$36,000	\$72,000	\$144,000	
<b>Reporting</b>				
Data compilation and quality review	TBD	TBD	TBD	In-kind by CVDWPWG; some Delta RMP support TBD
Program management and preparation of summaries	TBD	TBD	TBD	In-kind by CVDWPWG; some Delta RMP support TBD
Pulse report or other publications	TBD	TBD	TBD	SFEI support, if necessary
<b>Total RMP Cost</b>	<b>\$36,000</b>	<b>\$72,000</b>	<b>\$144,000</b>	

**MWQI Incremental Cost  
Estimate for Sample  
Collection [In-kind  
contribution]**

	<b>Alternate Months</b>	<b>Monthly</b>	<b>Twice Monthly</b>	
Project Initiation and Planning	\$6,400	\$6,400	\$6,400	
Pre-event Preparations	\$2,100	\$4,200	\$8,400	
Sample Collection	\$24,200	\$48,400	\$96,800	
Post-event Wrap-up	\$1,200	\$2,400	\$4,800	
<b>Total MWQI In-Kind Services Provided</b>	<b>\$33,900</b>	<b>\$61,400</b>	<b>\$116,400</b>	All services provided as in-kind by MWQI

**1.3.2. Year 2 Cost Estimate**

Year 2 activities would include continued monthly ambient and intake monitoring with the addition of area-focused studies of sources, infectivity, and hydrodynamics. Year 2 costs will then be based on results from Year 1 studies, and would be a continuation of the Year 1 funding level with additional funding of special studies of the “focus area”. Additional Year 2 costs are presented in **Table 9**.

Again, Year 2 costs will be mitigated by MWQI sample collection and in-kind contributions from the Central Valley Drinking Water Policy Workgroup participants. The Delta RMP would primarily fund the analytical costs and administratively account for in-kind contributions. Total costs to the RMP in Year 2 are then expected to include a second full year of ambient monitoring (\$72,000) plus a selection of the Year 2 Special Studies cost (\$47,250), for a total cost of \$119,250.

**Table 9.** Estimated additional cost for Year 2 special studies.

<b>Special Study Component</b>	<b>Estimated Additional Cost</b>	<b>Note</b>
Source Monitoring	None to RMP	It is expected that sources within the study-area would collect and analyze <i>Cryptosporidium</i> and <i>Giardia</i> samples to rule out their contribution. Performed as TBD in-kind contribution.
Microbial Source Tracking	\$22,500	Assumes six samples collected over six events
Infectivity Monitoring	\$24,750	Assumes six samples collected over six events
Sample Collection	None to RMP	Incremental in-kind contribution from MWQI for collection of additional samples at \$5,000 to \$10,000
Administration, Coordination, and	None to RMP	Same as Year 1 in-kind contribution from CVDWPWG

## Delta RMP Year 1 Monitoring Design Summary – PATHOGEN STUDY

Reporting		
Fate and Transport	TBD; minimum \$250,000	The subcommittee deferred developing specific costs pending collection of additional data and literature research. Without additional data, the feasibility of the study could not be adequately assessed. A smaller pilot scale (i.e., bench-top) study may first be necessary.
<b>Total Cost to RMP</b>	<b>\$47,250</b>	See text for additional discussion of in-kind contributions

### **1.3.3. Project Administration, Coordination, and Reporting**

In addition to the monitoring costs presented in the sections for Year 1 and Year 2, the total Pathogen Study costs will include costs during both study years for project administration, coordination, and reporting, in addition to the costs for literature review and the Year 2 hydrodynamics assessment. It is expected that much of these costs will be offset by in-kind contributions from the CVDWPWG members and participating agencies. The specific tasks that are expected to occur over the duration of the study for both ambient monitoring and special studies include:

- Project planning and initiation;
- Pre-event planning [performed in-kind by MWQI];
- Post-event wrap up [performed in-kind by MWQI];
- Data compilation and quality review;
- Program management and preparation of progress summaries;
- Data report/publications.

One-time, or focused tasks for Special Studies include:

- Literature assessment of fate and transport processes;
- Year 1 data assessment to evaluate potential trigger exceedances and determine Year 2 Special Study focus;
- Year 2 study plan;
- Hydrodynamics assessment.

## Appendix 1 - Roles and Responsibilities for the Pathogen Study

Role	Responsibilities
Ambient network monitoring	<p>MWQI staff</p> <ul style="list-style-type: none"> <li>• Coordinate sample collection by</li> <li>• Coordinate delivery of samples to analytical lab using couriers</li> </ul>
Drinking Water Agency Coordination	<ul style="list-style-type: none"> <li>• Work with drinking water agencies to find out the schedule of LT2 sample collection</li> <li>• Obtain drinking water agency data.</li> <li>• Calculate likely bin levels from drinking water intake data, starting when 8 months of data are available</li> </ul>
Program Support – Monitoring Coordination	<ul style="list-style-type: none"> <li>• Coordinate with MWQI to arrange ambient sampling dates</li> <li>• Arrange for couriers to deliver ambient samples to analytical lab, and coordinate with analytical lab for sample delivery</li> </ul>
Program Support – Data compilation and analysis	<ul style="list-style-type: none"> <li>• Compile ambient and drinking water intake laboratory data, perform QA/QC for ambient data</li> <li>• Produce data summary products</li> </ul>
Program Support – Year 2 Study Plan	<ul style="list-style-type: none"> <li>• Once 8-12 months of data are available, evaluate data for Year 2 special studies according to process in monitoring plan</li> <li>• Develop Year 2 study plan</li> </ul>